AUGUST 1904

Physical & Applied Sci. Serials

The TECHNICAL WORLD

THE WHITEHEAD TORPEDO

By ROBERT G. SKERRETT

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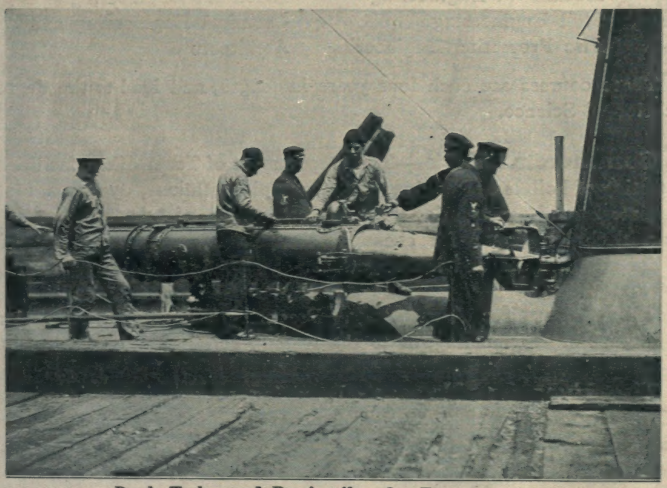

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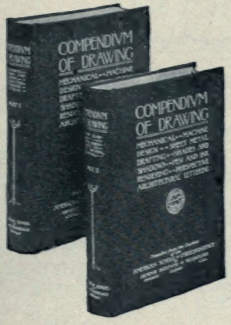

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THE TECHNICAL WORLD

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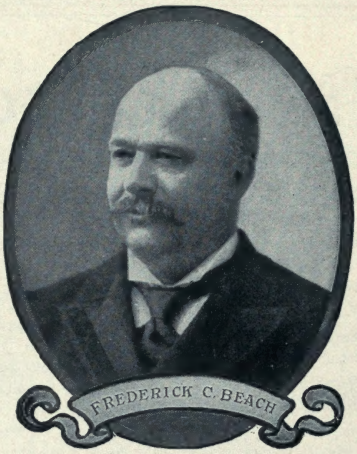

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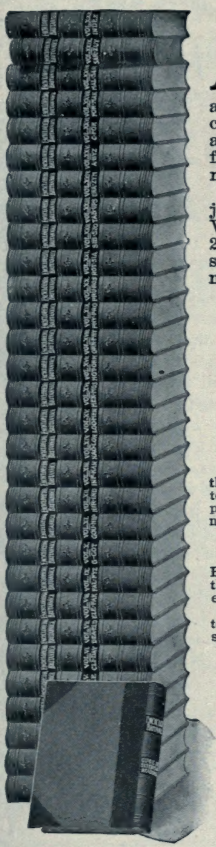

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(See Page 705.)

CHARLES W. ELIOT, LL. D.

President, Harvard University.

The
Technical World

Volume I AUGUST, 1904 No. 6

The Whitehead Torpedo

A Submarine Engine of Destruction which is Doing Very Effective Work in the Russo-Japanese War

By ROBERT G. SKERRETT

Formerly of the Navy Department, Washington, D. C.

THE PART TAKEN by torpedo craft in the present struggle between Russia and Japan has naturally brought the torpedo itself prominently before the world; and the public at large is not unreasonably interested in that most wonderful instrument of destruction which, in its turn, has brought into being the "mosquito fleets" of naval powers.

Historical Retrospect

The disastrously destructive work of passive submarine mines during the War of the Rebellion — crude though they were — set a number of inventive minds to thinking; and, in 1864, Captain Lupuis of the Austrian Navy conceived a style of small fire ship, or floating torpedo, which should be self-propulsive and dirigible. His idea was to propel the torpedo by clockwork, and to guide it to the target by means of lines leading back to a controlling base. After numerous experiments, he laid his scheme before the Austrian naval authorities, who promptly condemned his method of propulsion and the manner in which he proposed to steer his torpedo. In the hour of his greatest difficulty, he met Mr. Whitehead, an Englishman, then in charge of an engineering concern at Fiume; and to Mr. Whitehead, as a practical mechanic, Captain Lupuis turned over the problem of making something workable out of his own first crude notions.

Mr. Whitehead promptly abandoned Captain Lupuis' scheme, and proceeded to evolve a torpedo that should run *under* the surface, and which, when once started on its errand of destruction, should be self-controlled in every particular. The task he set himself was indeed a difficult one, for it was pioneer work; but, after two years of nearly ceaseless work and experimentation, his first torpedo was ready for trial. Having been built in secret, for only his son and a trusted fellow mechanic were admitted to the mystery, its first appearance was all the more startling.

Lieutenant Armstrong, late of the British Navy, says:

"The first Whitehead torpedo was of a very different shape indeed from those of the present day. It was built of steel, was 14 inches in diameter, 16 inches at the fins, and weighed 300 pounds. Its explosive charge was 18 pounds of dynamite. The motive power was compressed air charged to a pressure of about 700

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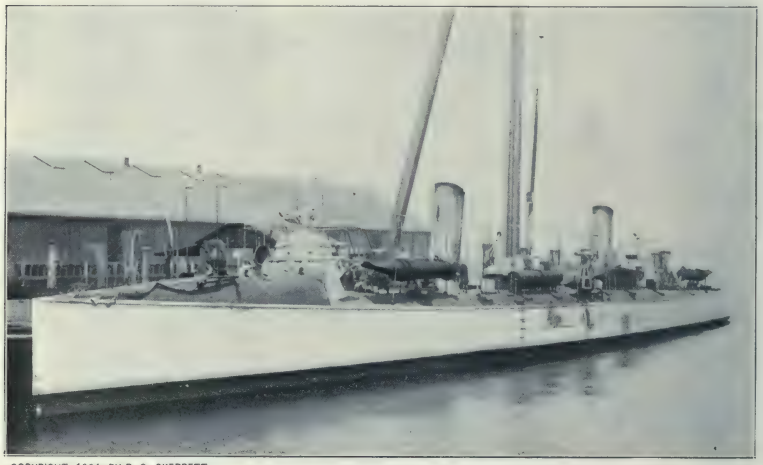
pounds to the square inch; and the air chamber was made of ordinary boiler plate. The speed of the torpedo, when running under favorable circumstances, was but six knots, and that only for short distances. * * *

"The torpedo, although a marvel of ingenuity, was, on the other hand, exceedingly erratic in its performances. In one important particular it continually failed, and that was in the regularity with which it kept its proper depth in the water. At times it would run skimming along the surface, whilst at others it dived down to the depths and explored the bottom. Not, by the way, that the torpedoes of the present day do not sometimes do the same; but still it is the exception and not the rule, and whenever they indulge in such vagaries they are at once examined and readjusted."

Encouraged by the Austrian Government, who gave the torpedo extensive practical trial, Mr. Whitehead gradually evolved an improved order of the weapon, and, among other things, worked out the primary idea of the "balance chamber"—that part of the torpedo which now controls its uniform depth of submergence. So precious was this secret deemed, that, until a few years ago, the most elaborate precautions were taken to keep the details from the world. A room with carefully shielded windows kept the curious from seeing in, while a sentry stood continually on guard at the door. Like most secrets of the sort, it leaked out in time, and the details of the mechanism proved to be beautifully and wonderfully simple.

Interesting as the gradual development of this torpedo has been, space now will not permit us to dwell upon the various stages of its development—in which many others besides Mr. Whitehead have worked. From a weapon of most erratic performance even under favorable conditions, it has grown to be the marvelously precise instrument of to-day; and, within its range, so experts claim, it is even more accurate than the best of modern ordnance and is less affected by local conditions. At this very time our own naval authorities are experimenting with an improved design—the result purely of American inventive genius—which promises to make the Whitehead in this new form even better and more formidable than those that have already scored so effectually in the Far East.



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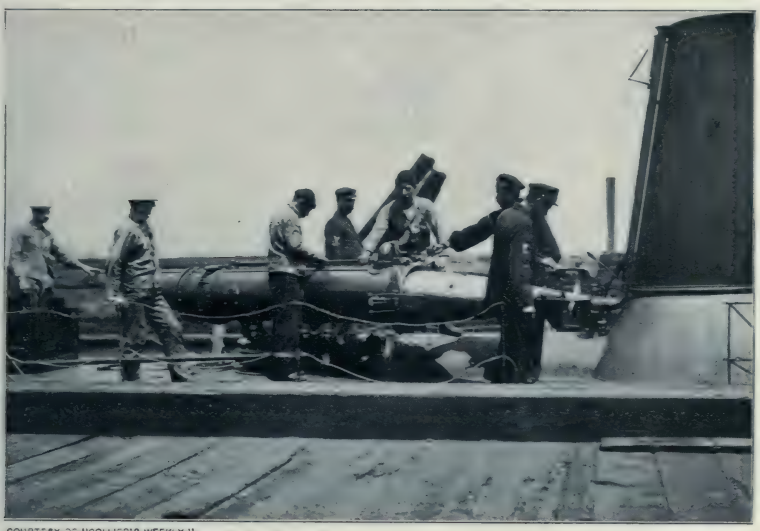
U. S. TORPEDO-BOAT *FOOTE.*

The modern 18-inch Whitehead has a speed of 28.5 knots for a distance of 800 yards, carries an explosive charge of 132 pounds of gun-cotton, weighs something over 1,200 pounds, with air stowed in the air chamber to a pressure of 1,500 pounds to the square inch. This mechanical fish, which is nearly 17 feet long, is

made of the finest steel, and is expelled from the torpedo tube either by the impulse of a small charge of powder or the thrust of a blast of compressed air.

The matter now of interest is a general notion of how the torpedo works in the fulfillment of its mission of bearing that



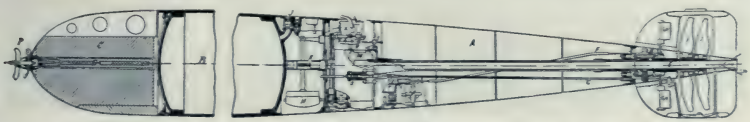
COURTESY OF "COLLIER'S WEEKLY."

DECK TUBE AND PROJECTILE OF A TORPEDO-BOAT.

deadly charge of gun-cotton certainly to the target of an enemy's ship.

The Head

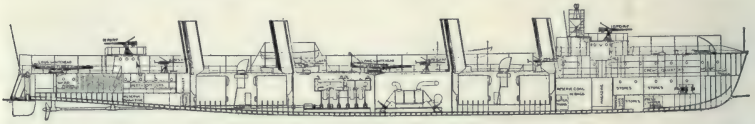
The torpedo is ordinarily supplied with two heads—the "practice" head and the "war" head. The former is filled only with water, while the latter bears that powerful charge of gun-cotton. It must be plain that without some form of protection against accidental discharge, a torpedo becomes a dangerous neighbor, even to its friends, the moment its war head and primer are shipped. In order to prevent the striking rod from working back against the explosive primer of fulminate of mercury, two safety devices are provided. The first is a small propeller threaded on to the striking rod, and holding the latter in place until, through the action of the water, after the torpedo has run about fourteen yards, this propeller unscrews itself and to that extent frees the rod. This device is intended to make sure that the torpedo gets safely clear of the firing ship. Now, when a torpedo is in a submerged tube, the swash of the water, if the vessel be under way, might work this safety propeller loose; and accordingly, as an added precaution, there is a stout shearing pin



LONGITUDINAL SECTION OF 18-INCH WHITEHEAD TORPEDO.

P, Plunger or striking rod. g, Safety-pin. G, Gun-cotton charge. D, Priming charge. R, Air flask. J, Charging valve. K, Hydrostatic valve. H, Pendulum. M, Engines. N, Mechanism for controlling submergence and stoppage. S, Submergence valve. X, Valve case. Y, Air lever. O, Immersion servo-motor. L, Pressure regulator. V, Gyroscope. T, Spring for starting gyroscope. U, Direction servo-motor. F, Controlling rod to vertical rudders. E, Propeller shaft. B, Shaft gearing.

of copper which holds the rod in place until the heavy blow of actual contact breaks the pin and drives the plunger against the primer. For target practice, of course, the war head, ordinarily stowed securely below in a special magazine, is replaced by a nose which can be hammered and banged without risk of dry gun-cotton, which is sensitive, and the initial detonating primer of some thirty odd grains of fulminate of mercury, which, when ignited by percussion, expands to 2,500 times its normal size, and deals to the dry gun-cotton a frightful blow, and that, in turn detonates the otherwise insensitive wet gun-cotton.



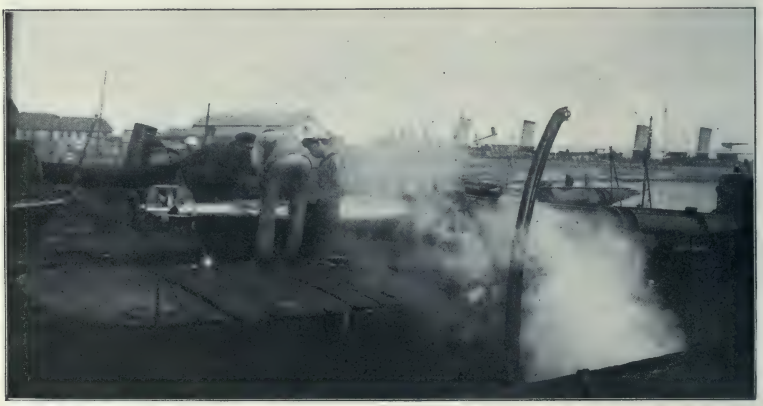
LONGITUDINAL SECTION, SHOWING INTERNAL ARRANGEMENT OF TORPEDO-BOAT DESTROYER.

life; and a most recent design of practice head will be made of copper, and will be soft enough to collapse on contact with a ship's side. The object is to use the torpedo thus supplied, in mimic battle, and to have a means of scoring many actual hits with safety and without loss of the torpedo.

As has been said, the explosive charge consists of 132 pounds of gun-cotton.

The Air Chamber

Immediately aft of the head comes the air chamber, which, while carrying air at a pressure of 1,500 pounds to the square inch, must be able to withstand without deformation a test pressure of 2,250 pounds. It is notorious that, while the modern 18-inch Whitehead has carried for some years air enough to propel the weapon for 2,000 yards, the torpedo, be-



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PREPARING FOR A RUN.

Naval Torpedo Station, Newport, R. I.

This charge is of wet gun-cotton, which is notoriously insensitive to ordinary shock and can be roughly handled with the utmost safety. To make this mass destructive, a very violent blow is necessary to detonate it. Herein comes the mission of the primer of six ounces of

cause of errors in lateral directions, which multiplied with the distance, was called upon to run only for 800 yards. This, however, was changed with the introduction of a wonderfully clever corrective instrument, of which we shall speak later. The cylinder, or air cham-

ber, is constructed of the finest of compressed steel, which is finally worked down to a thickness of three-tenths of an inch. When fully charged, it becomes itself an explosive body of no mean force, as more than one accident has proved.

The Balance Chamber

Next abaft the air chamber comes the balance chamber, so long a well-guarded secret; and in this water-tight space are the depth-controlling mechanism and some of the important valves. Let us see how the balance mechanism works. Primarily it consists of two parts: a delicately pivoted pendulum or weight, and a valve affected by hydrostatic pressure. The pendulum, by its upper arm, is connected with a controlling rod leading directly to the horizontal rudders at the tail of the torpedo, which, moving up and down, control the weapon in a vertical direction. If the torpedo plunges by the head, the pendulum, which moves longitudinally, swings forward and brings the horizontal rudder up, forcing the torpedo toward the surface until the weapon lies horizontal once more. This, however, could not by itself keep the torpedo at a uniform depth; and at this point the hydrostatic valve comes into play. This valve, while open to the influence of the sea, is yet shielded from the water by a stout India rubber diaphragm. The active agent of this valve is a spring, carefully standardized, which can be set to work effectually at depths of from six to fifteen feet. The valve is connected to one of the arms of the pendulum. Now, as the torpedo starts below its designed depth, the external water pressure, pushing against the India rubber diaphragm and the opposing spring, causes the valve rod to move just to the extent to which the water pressure overbalances the set spring; and this motion, in turn, is transmitted to the horizontal rudders. The torpedo is in this way caused to return to its old depth, where the spring again balances the external water pressure, and the rudders return to their normal position. If the torpedo rises, the spring overcomes the lessened external pressure, and moves the rudders in the opposite direction, thus forcing the torpedo back to its designed submergence. Neither the spring nor the pendulum, in itself, is powerful enough to work the rudders directly against the pressure of the passing water when at full speed. To aid them in this work, there is provided a small servomotor, with air impulse, which, being supplied with air through a small valve controlled by the pendulum and the hydrostatic valve, has ample power to move the rudders.

U. S. TORPEDO-BOAT DESTROYER *PERRY*.

"Bainbridge" Class of 16 vessels. Length, 245 ft. Breadth, 23 ft. 7¼ in. Draft, 6 ft. 6 in. Displacement, 420 tons. Contract speed, 29 knots. Coal, 139 tons. Armament: 2 long 18-in. Whitehead torpedo tubes; 2 3-in. rapid fire guns; 5 6-pounders. Complement, 73.

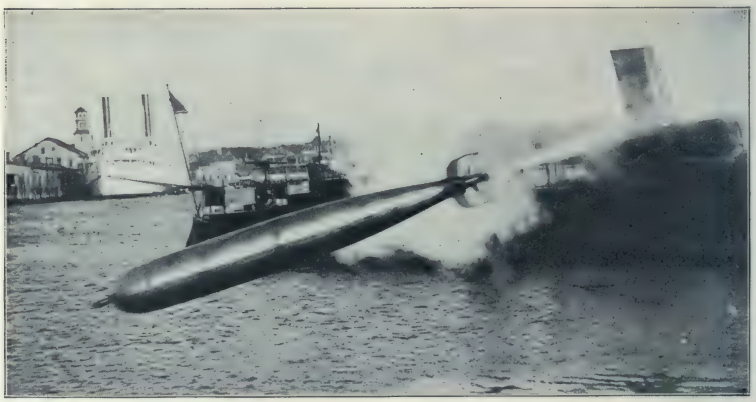
The Starting Valve

This valve turns the air on to the engines. It is primarily actuated by a small lever which projects beyond the upper

surface of the torpedo, and which is tripped—thereby opening the air duct—as the torpedo passes out of the tube. If the air, at this time, however, were turned on full, the engines would be made to race at the violent rate of 2,000 revolutions a minute, which might rack the torpedo and some of the delicate operative mechanisms. To prevent this, there is, just back of the starting-valve lever, a small flat tripper, which, in turn, controls a delay-action valve that checks the passage of air until this tripper has been thrown back by the action of the water after the torpedo has plunged and the propellers are buried. Even now the full pressure of air in the flask is not allowed to reach the engines, for, if such were the case—apart from the tax upon the engines—they would be driven at constantly reduced speed and the travel of the torpedo would be uncertain. To prevent this, a reducing valve yet intervenes between the air supply and the engines. This little valve is an ingeniously contrived affair, in which, by a system of springs and sliding vents and by the opposition of the air supply, the air, acting against itself, is made to feed at a constant and reduced pressure to the engines.

The Engines

The engines are of the three-cylinder Brotherhood type and beautifully compact; and, while the cylinders are less than four inches in diameter and the pistons have a stroke of only three inches, still they develop an energy of fully 56 indicated horse-power. These engines drive directly a single shaft, which, in turn, drives directly only one of the two propellers. The other screw, fitted to a sleeve actuated by gearing that engages the primary shaft, is driven in the opposite direction. This is because the propellers are "rights" and "lefts," so that the resultant thrust may be uniform and directly ahead.



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AN 18-INCH WHITEHEAD TORPEDO IN ACT OF EXPULSION.

Showing Blast of Exhausted Air.

The Buoyancy Chamber

Back of the engine space comes the buoyancy chamber, which, as its name denotes, is designed to give the torpedo the necessary buoyancy. This buoyancy, when the air flask is charged at 1,350 pounds, is just zero; and when fully charged, is negative to a considerable extent, showing thereby the weight of compressed air. This chamber, because it must withstand considerable outside pressure, is securely braced by steel rings within. In this chamber, at the bottom

and near the forward end, is the gyroscopic mechanism for controlling the vertical rudders for horizontal steering.

COURTESY OF "COLLIER'S WEEKLY."

WHEN JACK'S ASHORE.
Single-Stick Exercise in the Brooklyn Navy Yard.

The Gyroscope

The gyroscope, commonly known as the Obry gear, is, as the latter name suggests, not the invention of Mr. Whitehead; and, wonderful as the diving mechanism is, the Obry gear is still more so, having done more to widen the range of the torpedo and to make it more certainly formidable than any other of its marvelous mechanical features.

Until the Obry gear appeared, the lateral course of the torpedo was very erratic. Dents or other imperfections in the surface of the torpedo shell would cause it to steer badly. On striking the water, especially if the vessel were under way, the weapon might be deflected from its true course—especially so, if the torpedo took a *roll* on entering the water, thus causing the horizontal or depth rudder to become *pro tem* a vertical or a lateral rudder. The Obry gear has now reduced these errors to a minimum; but, like all beautifully and delicately adjusted mechanisms, it requires a deal of care and the most careful sort of handling.

The Obry gear is really a finely balanced bronze top, weighing less than two pounds, very delicately hung in double gimbals as is the ordinary ship's compass, and, of course, free to move in any direction. This top is set spinning by a powerful spring, set free by the same lever that turns on the air as the torpedo passes out of the tube; and a velocity of

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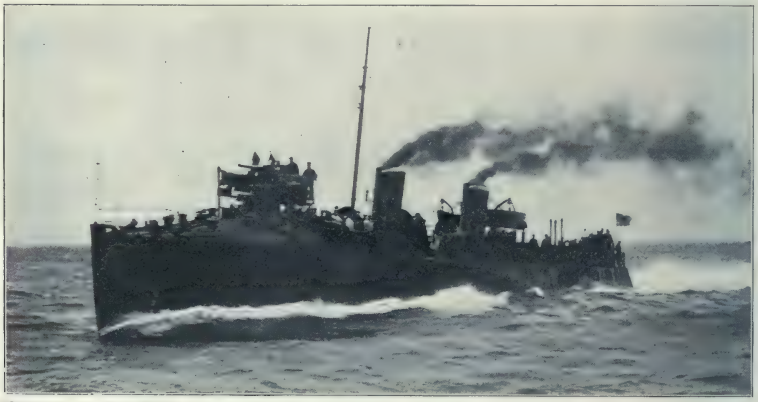
U. S. "DESTROYER" AT ANCHOR.

revolution of 2,200 turns a minute is thus given to the gyroscope. The axis of the Obry or the gyroscopic wheel itself is in line with the longitudinal axis of the torpedo; and, no matter how the torpedo swings to right or left, the gyroscope, because of its inherent directive force, remains in its original position, which is, of course, the direction in which the torpedo was first aimed. Its corrective force is exercised in this way. To the outer ring or gimbal in which the gyroscope is hung, is attached a rod leading to a servo-motor; and, as the torpedo swings to right or left, the gyroscope, remaining stationary, causes the servo-motor—just as with the diving rudders—to operate a rod leading to the vertical rudders, which, in turn, are brought to a line with the Obry, thereby bringing the torpedo back to the direction of original aim. Under the circumstances, the course of a torpedo is more or less a continuous zigzag; but, because of the rapid corrections of the Obry, the curves of departure are slight. As a result of the introduction of the Obry gear, the range of the torpedo has been increased considerably, and, in a run of 800 yards, a lateral deflection of more than eight yards is prohibitive.

Already this article has exceeded its space limit, and yet has left much to be told of these "steel babies," each of which has its own characteristics, and each of which must accordingly be humored and coaxed into perfect working accordingly as they prevail.

It may be of interest to know that the Navy Department is now experimenting with a turbine-driven torpedo with an alcohol superheater, by which still greater range and higher speeds will be attained. For a distance of 1,200 yards a speed of 35 knots is promised; and for a range of 4,000 yards a torpedo is being built that will give a speed of 26 knots. In these cases, the air chambers are considerably enlarged, and the air is to be stowed in them at a working pressure of 2,250 pounds to the square inch.

Such are the constant advances that are being made; and it will be with such perfected instruments of destruction that we shall meet our enemy if he come in the reasonably near future. One especial significance of the development of the torpedo is that it widens the range of effectiveness of all craft designed to use this device in warfare; and to none will it apply with more force than to the rapidly evolving perfect submarine.



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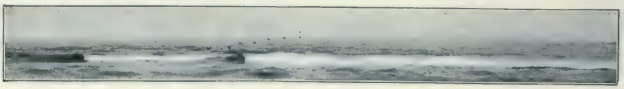
BRITISH TORPEDO-BOAT DESTROYER *FAME*.



The Government and Irrigation Construction

Possibilities of Reclaiming the Arid and Semi-Arid Lands of the West and Southwest.—Import of the National Irrigation Act

By GUY E. MITCHELL

ON JUNE 17, two years ago, a law was passed by Congress providing for the construction, by the Federal Government, of irrigation dams and ditches in the sixteen arid and semi-arid States and Territories of the West. The statement of the proponents of this law, that with its passage the American Government became committed to a work, the greatest of any internal problem yet undertaken by the nation, was greeted with somewhat incredulous smiles and was set down as the phantasies of over-enthusiasm. The new law carried with it an appropriation of about $6,000,000; it also provided that all moneys received from the sales of the public lands of the arid region should be automatically covered into this "reclamation fund." Sales of these lands have been large, and the fund now amounts to about $25,000,000. All of this money has been specifically applied by the Secretary of the Interior, the cabinet official charged with the execution of the law, to the construction of huge irrigation works—in Nevada, Arizona, New Mexico, Wyoming, North Dakota, Idaho, Washington, and other States—costing in every instance millions of dollars. The great Tonto dam and canal near Phœnix, Arizona, it is estimated, will cost between $3,000,000 and $3,500,000. As the work of surveying and reconnoissance has progressed, the claim of the irrigationists of the importance of this work does not seem perhaps so extravagant when it is seen that this government policy—which, doubtless, will later become as broad and comprehensive as our river and harbor construction—contemplates the reclaiming of many million acres of Western desert waste, and transforming it into thousands of productive farms and homes.

STACKING ALFALFA IN THE YELLOWSTONE VALLEY, MONTANA.

Alfalfa, a plant allied to the Clover family, is the great irrigated forage crop of the West. It thrives best under conditions of comparative drouth, and hence is a reliable staple crop in semi-arid regions.

Vast Areas Already Irrigated

While irrigation is new as a government undertaking, farming by its means is as old as the world's history; and even in the United States, where its practice was begun as a substitute for rainfall, great progress has already been made through private enterprise. The last census figures show that, in round numbers, 7,500,000 acres are irrigated in the western half of the country; and many magnificent stream barrages have been erected to control the floods and form artificial lakes, from which the water can be drained to be applied to the thirsty soil in fertile valleys lying below them.

The greatest disciple of American irrigation was John Wesley Powell, for many years Director of the United States Geological Survey. While not an engineer, Major Powell was an eminent hydrographer, and, in his wide travels throughout the arid region, foresaw in a remarkably accurate degree the ultimate development through irrigation of that great region. Many of the sections in the West, which, as a result of his necessarily somewhat hasty and superficial reconnoissances, he prophetically pictured as having great futures before them through the storage and utilization of their water supplies, are now upon the threshold of that development through the subsequent accurate surveys of the Geological Survey; and it was due to his love for, and belief in, that broad arid region, that Congress has appropriated at different times during the past fifteen years, over a million dollars for its exploration and survey. When the national Irrigation Bill became a law, it found in the Hydrographic branch of the Geological Survey a well-equipped and well-informed bureau ready to take up immediately the great work of irrigation engineering construction.

During the last twenty years the Survey has directed its researches throughout the arid West; and Major Powell's mantle now rests upon the competent shoulders of Frederick Haynes Newell, the present National Hydrographer, whose tutelage began under Major Powell some fifteen years ago.

Construction and Development

The work of the Geological Survey has been of unquestioned benefit to many of the great private irrigation enterprises that have been projected, some of which have been carried to successful completion. There are two distinct phases, however, of the irrigation question—namely, engineering construction, and the application of water to land. Successes in the two branches are by no means coincidental. It is an unfortunate fact that many of the private irrigation works of the West, while they have been great successes from an engineering standpoint, have been failures as irrigation enterprises. This latter fact is due to an insufficiency of the very data which the Government is careful to secure before entering upon any work of construction. An illustrative case is the Sweetwater dam near San Diego, California. This is a magnificent structure of solid masonry; but, owing to a lack of knowledge concerning the average flow of the Sweetwater River, and to the too great confidence and glowing representations

TYPICAL ATTEMPT AT FARMING WITHOUT IRRIGATION.
Farm Site near St. Anthony, Idaho.

—or, rather, misrepresentations—of the promoters of the project, the orange and lemon groves served by it have suffered terribly from the want of water, and have in many cases reverted from five

THE IRRIGATED "ORANGE" VALLEY OF REDLANDS, CALIFORNIA.

Watered largely by pumping from underground sources. Twenty years ago a desert worth only $1.00 an acre.

hundred dollars an acre land to the original desert condition. For some seven years the rainfall on the Sweetwater watershed was insufficient, not only to fill the dam and supply the orange orchards, but even to create a run-off and cover the broad bottom of the reservoir. This splendid dam stands as a monument to the folly of irrigation construction in an arid region without sufficient meteorological and stream-gauging data, and is but an exaggerated example of a large number of projects in the West and particularly the Southwest.

Full Hydrographic Data Essential

Too full and complete data cannot be accumulated before entering upon any such great work, for the most serious and heartbreaking experiences are likely to follow upon hasty or ill-advised work of that kind, entailing untold loss and hardship upon the enthusiastic and hopeful settlers, who in many cases stake their all upon the expectation of a good and constant water supply, which, when too late, they discover to be a chimera.

The national Government, in its irrigation operations, is peculiarly fitted to undertake and carry out these great works. There are many things to be considered besides the mere engineering problems involved—the construction of a dam across a canyon, and of great canals to carry the water impounded to the farm laterals. The catchment area

IRRIGATED PUMPKIN FIELD, CARMEL VALLEY, CALIFORNIA.

must be considered, covering perhaps hundreds of thousands of acres of watershed; and the area of land to be irrigated must be rigorously confined to the certain capacity of the streams flowing into the reservoir. In the West, the Govern-

FURROW IRRIGATION OF ORANGE TREES.

Near Los Angeles, California.

AN IRRIGATED ONION PATCH IN CALIFORNIA.

ment is the great land and forest owner; and it must with a strong arm conserve the forests covering these watersheds, and thus protect the water supply. Private capital engaged in lumbering operations is too apt to denude entire mountain ranges and foothills of their forest cover, regardless of the rights of the irrigators in the plains and valleys below.

Seventy-Four Million Acres Irrigable

The President has said in his official messages that the administration of the remaining public lands and of the nation's forests constitutes the greatest of our internal questions; and this statement cannot be gainsaid by any student of the subject. According to the detailed estimates of the Geological Survey, there are some 74 million acres in the West which can yet be reclaimed from the desert by irrigation, if all the available waters of that region are fully utilized by storage and otherwise. The Government still owns in fee simple some 500 million acres in that region; and, while it has been policy to make it easy in every way for the settler to acquire his just share of the public domain for the purpose of making a home, yet it is recognized that the public land laws have been too loose in their construction and too broadly administered, and that large areas have been absorbed for purposes

REDWOOD STAVE PIPE LINE.
A golden serpent carrying water to the orange orchards near Corona, California.

of private speculation and gain at the expense of, rather than in the interests of, the home builder.

The Congress recently adjourned witnessed a preliminary struggle between what may be termed the forces and influences of the *speculator* and those of the *home maker* in the attempt to secure the repeal of certain laws which are recognized as inimical to the full settlement and development of the West. Bills were introduced for the repeal of the Timber and Stone Act, the commutation clause of the Homestead Act, and the Desert Land Act. In spite of the President's statement in his first annual message, that these three laws had, in the interests of the speculator, been abnormally perverted from the intent with which they were enacted, and in spite of his specific recommendation to the present Congress, backed up by the report of a special Land Commission, for the repeal of the Timber and Stone Act, the land speculators and the live-stock interests prevented any final action on these measures. What can be accomplished in the coming short session of Congress, remains to be seen. The opponents of the repeal of these laws are bending every effort to prevent their consideration in any form, and it is a question when their repeal can be effected. That gross frauds have transpired under each and every one of them, is a fact beyond question; and a long line of Presidents, Secretaries of the Interior, and Commissioners of the General Land Office, after valiant endeavor to administer them rigorously, have recognized their inherent defects and have officially recommended their repeal.

CEMENT IRRIGATION DITCH, "LUCKY" BALDWIN'S RANCH, SOUTHERN CALIFORNIA.
No Loss of Water.

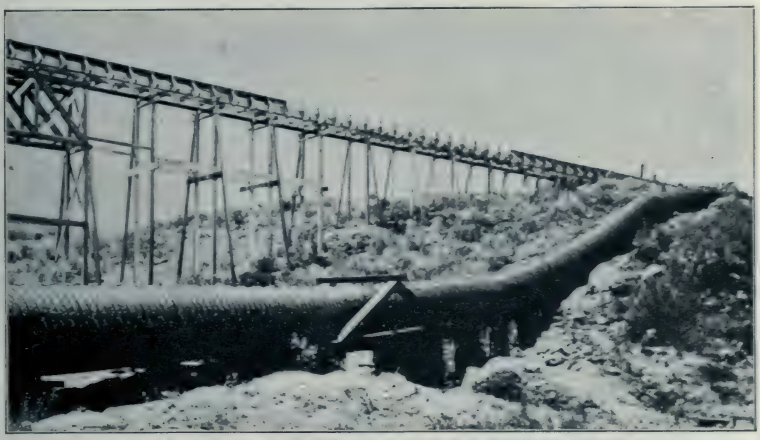
Public Lands for Home-Makers!

The foundation principle years ago laid down by the advocates of the national irrigation movement, proclaimed that, while the great irrigation works of the West, too vast and complicated for private enterprise, should be built by the Government, at the same time the nation should reserve its remaining land for actual settlers; and the laws should be

so readjusted as to preclude speculation in land and water, to the end that the irrigable land should be divided up into small and productive farms for genuine settlers and farmers, who would live upon them and would use the water for crop-growing and establish permanent homes.

The provisions of the Irrigation Law are stringent in this regard, and the speculators have virtually admitted that this law holds out small hopes for them. It provides that no man can acquire title for more than 160 acres under a modification of the Homestead Law, and then only after ten years' residence, and improvement, and the payment to the Government in ten annual installments of his share of the actual cost of the irrigation dam and main-line ditches from which he receives his water. From this it will also be seen that the law created a revolving fund. The $25,000,000 now available, even without additions, will, in the course of years, reclaim vast areas of land, for it will be used over and over again. As fast as the works are completed and the money paid back to the Government, it will be used over again for the construction of some new project. To cite a hypothetical case:

A dam and a canal cost a million dollars; the project reclaims 50,000 acres, the cost being $20 per acre. This area will be divided up into 160-acre farms (or less, within the discretion of the Government); and the settler on one of these tracts will have ten years in which to reimburse the Government for his *pro rata* share of the expense of construction —$3,200, or at the rate of $320 a year. Within ten years this million dollars will all have been covered back into the "Reclamation fund," and most of it will, by that time, be already employed in the construction of some other dam.



OPEN IRRIGATION FLUME REPLACED BY REDWOOD PIPE FLUME.
The pipe line allows practically no waste of water.

The Government to be Repaid

These provisions of the act thus show a business-like feature, under which the Government is to receive back from the settler every dollar which it invests in these irrigation enterprises. In other words, the expenditure will be of the nature of a government loan to the settler without interest.

Some of the government irrigation works will reclaim only government lands, which will then be entered by the settler under the Homestead Act: in others, some of the land to be reclaimed is already in private ownership. This land must come under the government terms if it is to receive the benefit of the government storage; that is, it must be divided into the government units, not exceeding 160 acres, and pay for its proportionate share of the construction. It is here that the older land laws above mentioned are found to work against the best interests of the home maker and the

CONSTRUCTING MORENO ROCK-FILL DAM, SAN DIEGO COUNTY, SOUTHERN CALIFORNIA.
Explosion, August 4, 1897, of 25 tons of giant powder, displacing 200,000 tons of rock.

FIRST PREPARATIONS FOR BED-ROCK DRILLING ON COLORADO RIVER.

The full plans of the Government contemplate the Irrigation of about 1,200,000 acres of alluvial land in the rich semi-tropical basin of the Lower Colorado in California and Arizona.

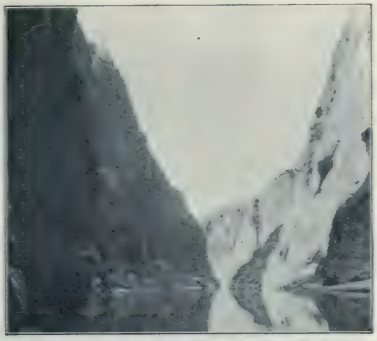
country. Lands which it is thought will probably be irrigated by the Government, are entered under these acts; and title is acquired without residence or cultivation, or with only a pretense thereat. They are entered by speculators who do not desire to live upon them after they shall have been irrigated, but who propose to stand between the Government and the real settler, taking their profit out of the latter, and endangering the success of the national irrigation policy.

The reason for the failure of so many of the large private irrigation schemes in the West, is traceable largely to the excessive price demanded for the lands and water, shutting out the settler without capital other than his strong arms and resolute heart to enable him to carve a home out of the desert. The consequence has been that the irrigated lands have not been fully colonized, and the income has been insufficient to keep up the interest on the irrigation bonds, the cost of repairs, and the annual charges on the works. While the Government is in a position where it cannot be forced into foreclosure, the success of its work will depend upon the prompt colonization of the lands when the water is turned upon them, and upon the repayment, by the settlers, of its investment. If the grim speculator stands between, asking an exorbitant price for lands which he has entered under these various land acts by an evasion of the spirit if

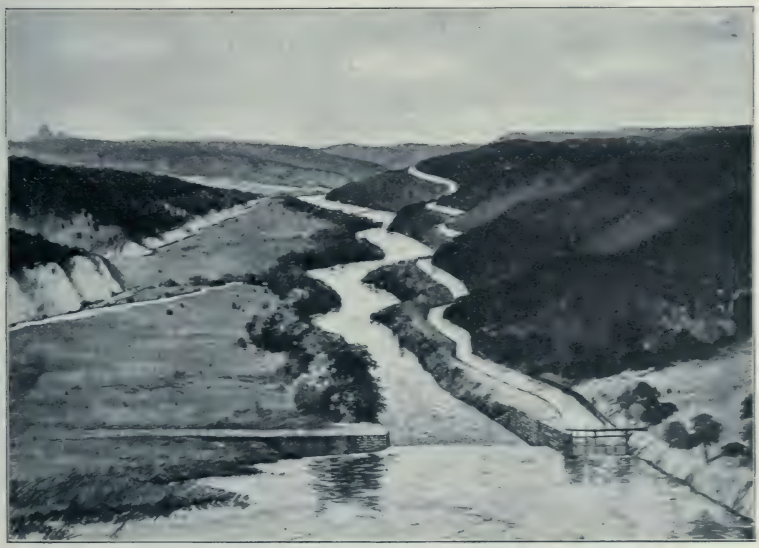
not of the letter of the law, the success of every such government work will be imperiled and menaced.

Government Reservations Insufficient

It is true that the Irrigation Act empowers the Government to reserve from such speculative entry any lands which it is proposed to irrigate; but this can be done only after sufficient preliminary survey to warrant the Government in proclaiming its intention to irrigate. The most extensive and exhaustive surveys throughout the entire arid West must be carried on, not only during the years immediately ahead, but for decades, before all the land capable of ultimate irrigation can be determined upon. In the meantime the shrewd land dealers of the various localities are more or less conversant with the local situations; and, as soon as a government surveyor alights from a train and proceeds to make even a preliminary reconnoissance of some reservoir site and tributary lands, speculators immediately awake to the possibility of making large fortunes, and assume control of the proposed irrigable lands by means of dummy land entries, which, if the sites prove advantageous, can be completed and title secured. In this manner, under the various methods and schemes for public land absorption, the enterprising land dealer will continue to stand between the Government and the home maker as long as these speculative land laws remain upon the statute book.



SITE OF ONE OF THE PROPOSED GOVERNMENT DAMS ON THE LOWER COLORADO RIVER.



PROPOSED GOVERNMENT CANAL FROM ST. MARY'S RIVER, MONTANA.

The days of engineering construction in the West unaccompanied by the vital questions of sufficient water supply and

SWEETWATER DAM, SAN DIEGO, SOUTHERN CALIFORNIA, LOOKING UP STREAM.

A Monumental Example of the Folly of Irrigation Schemes Based on Insufficient Meteorological and Hydrographic Data.

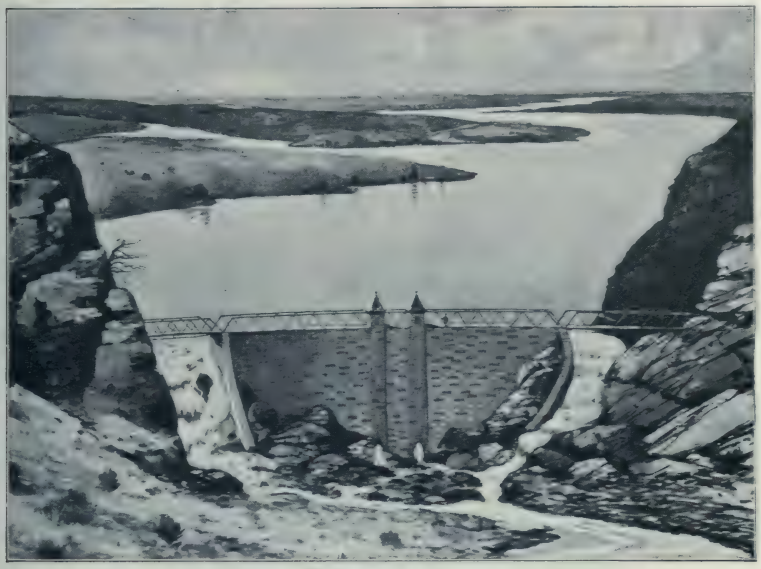
assured colonization, have passed. Before advertising for bids for dam and ditch building, the Secretary of the Interior must work out the problem of the certain success of the irrigation communities to be supplied from the government reservoir.

Substantial Engineering Construction

On the other hand, with the administration of the public domain based upon the principle that the lands of the nation shall be preserved for the men and women who will go upon them and make their homes and live there, the engineer-

SWEETWATER DAM, LOOKING DOWN STREAM.

ing features of the work, though great in extent, present a comparatively simple problem. Unlike much of the private irrigation construction with which the West has been cursed, the government works will be built for all time. Following the preliminary work of the hydrographers, the most eminent consulting engineers in the world are called to pass upon the plans worked out by the construction engineers of the Geological Survey. Where great dams 200, 250, or 300 feet in height are to be wedged in between the granite or tough sandstone walls of mountain canyons, they will become as fixed and everlasting as the towering rocks which they connect. Hydrographer Newell has stated as an illustrative parallel, that the government irrigation works are to be built somewhat after the manner of the modern railroad —with an idea to the most substantial construction and low cost of maintenance. In other words, it is not proposed to build structures which will either be carried away by flood or require rebuilding by the time the irrigators have finished their annual payments and own their proportionate share in the dams and ditches.

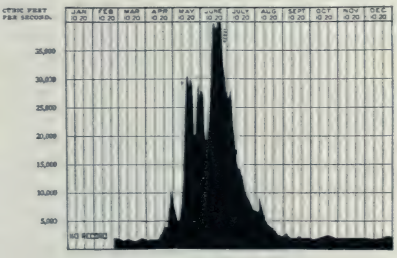


PROPOSED GOVERNMENT RESERVOIR, SAN CARLOS, ARIZONA.

To irrigate more than 100,000 acres. From Geological Survey plan.

Origin of the Geological Survey

In favorably reporting a bill for the creation of the Geological Survey, from



DISCHARGE OF GRAND RIVER, GRAND JUNCTION, COLORADO, 1896. SHOWING STORAGE POSSIBILITIES FOR IRRIGATION USE IN JULY, AUGUST, AND SEPTEMBER.

In the case of mountain rivers, the heaviest flow, known as the "June rise," is caused by melting snows.

the Appropriations Committee of the House of Representatives, the late Hon.

Abram S. Hewitt of New York delivered these statesmanlike remarks:

"I never contemplate the great maps of the United States which hang in this hall, or consider the natural resources of this broad continent, without a deep feeling of wonder, love, and praise. * * *

"When we come to contemplate the whole field of these natural resources available for food, for industry, and for commerce; when we attempt to grasp in one act of thought the length and breadth of the riches with which the Maker of the universe has loaded this continent on which happily our lot is cast; when we try to realize how every possible want, every material aspiration of man is bounteously provided for; when we consider how measureless are the values which spring into being at the touch of modern industry, and how these values when once created are solid and real and become incorporated into the enduring structure of human society; we may begin to estimate properly the measure of responsibility which rests upon this nation and its chosen rulers, not merely to preserve unharmed the priceless boon of civil liberty which leaves the individual citizen free to do his share in the work of development, but to adopt such measures as will prevent the waste of natural resources, clear the way of progress, and promote the triumphs of civilization. * * *

"Nations may spring into being, generated by the force of ideas alone; but the vigorous manhood, the mature growth of a State, can be nurtured and built up only upon the abundant and manifold productions of the earth. Nations become great and independent as they develop a genius for grasping the forces and materials of nature within their reach, and converting them into a steady flowing stream of wealth and comfort."

If these broad ideas shall prevail and be applied to our Western lands, and shall be carried a step further, to the end that the nation shall utilize its greatest national asset—its land and its water—developing it to such an extent that the former may become populated with the citizens of the Republic, living on the land, drawing their livelihood therefrom, and contributing to the general wealth, as laid down in the principles embodied in the national Irrigation Act, the present generation will witness a vast Western growth which will be another manifestation to the world of the mighty and growing resources of this continent.

The Cooper Hewitt Mercury Vapor Lamp

An Invention which may Revolutionize Modern Lighting Methods, and which Broadens the Range of Our Knowledge of Physical Phenomena

By P. H. THOMAS

THE COOPER HEWITT MERCURY VAPOR LAMP is one of the most striking of the many recent newcomers in the field of Applied Science. Most of the readers of THE TECHNICAL WORLD know of this new type of electric lamp through the reports of demonstrations by Mr. Hewitt and others, and more recently, perhaps, through its actual commercial use for various purposes.

Practically all earlier forms of lamp involve the production of light by means of incandescent solids—for example, incandescent carbon—either in flames, in the electric arc, or in the thin filaments of incandescent lamps; or, sometimes, other material raised to incandescence by heat, as in the Welsbach mantle. In the Cooper Hewitt lamp, on the other hand, the electric current causes light to be emitted by the vapor of mercury at an

extremely low pressure in an exhausted tube. The lamp, as ordinarily constructed for actual use, consists of a glass tube about an inch in diameter and from two to four feet long. The tube is carefully sealed and the air exhausted, a little liquid mercury being enclosed, from which there evaporates a small quantity of mercury vapor.

The Cooper Hewitt lamp first attracts attention through its unusual color, or rather its unexpected effect upon the color of objects seen under its light. But, seriously, its chief scientific interest results from the fact that it elucidates a new group of phenomena previously little understood. It has a great practical value because it provides an extremely abundant and efficient light of a quality most excellently fitted for many kinds of work.

Forms of Vacuum Lamps

The passage of electricity through a vacuum is the underlying principle of the Cooper Hewitt light. There are, however, other types of apparatus in which electricity passes through a vacuum, so that this alone will not serve to distinguish Mr. Hewitt's apparatus from that of other scientists. The well-known "Geissler tubes," "Crookes tubes," and "cathode-ray tubes" are examples of previously used types of apparatus in which electricity passes through a vacuum.

The Geissler tube consists of a sealed glass container, often made in fantastic shapes, having a wire leading through the glass at each end, and containing a small quantity of rarefied gas of some kind or other within the chamber. An intermittent current of electricity causes in this a faint glow, whose color varies with the composition of the gas inside, often giving most beautiful effects. These tubes, however, give so little light as to be shown to advantage only in the dark.

The Crookes tube also consists of a glass container, usually less complicated in form than the Geissler tube, in which as perfect a vacuum as possible is produced. It has terminals similar to those of the Geissler tube, and, when operated by a current, serves, similarly to the latter, to give a weak phosphorescent light.

The cathode-ray tube is similar to the Crookes tube in construction, but, instead of giving fluorescence, serves for the production of rays for other purposes.

Superiority of the Mercury Vapor Lamp

By none of the types of apparatus just described can a useful quantity of illumination be produced, while, on the other hand, from the Cooper Hewitt lamp a very abundant light is obtained. What is the essential difference between them? It is twofold. In the operation of the Geissler and Crookes tubes, a high-voltage intermittent current of small power must be used—such a current as is obtained from an induction coil by using a current interrupter in the supply circuit according to the methods well known for such coils. As a result, no considerable amount of power can be converted into light, on account of the practical limitations of the induction coil and also of the tubes themselves. The Cooper Hewitt lamp, on the other hand, operates with direct current at relatively low voltages—for example, on 100-volt to 120-volt circuits, such as are regularly used for incandescent lamps. As a consequence, comparatively large amounts of power can be utilized for the production of light in such a form as to be readily available. The efficiency of the Cooper Hewitt lamps is very much higher than that of the other types of vacuum apparatus.

D. MacFarlan Moore has recently produced a lamp upon the principle of the Geissler tube, which is a marked advance over the laboratory type, but which cannot compare in illuminating power and efficiency with the Cooper Hewitt mercury vapor lamp. It has considerable actinic power, however, and can be used for photographic purposes with considerable effectiveness.

The second difference, and, scientifically speaking, the distinguishing difference, between the two types of vacuum apparatus, lies in the condition of the "negative electrode resistance," so called. In a Cooper Hewitt lamp a very great resistance to the *starting* of current exists at the "negative electrode," which resistance may disappear during operation under the proper conditions. The fuller explanation of this phenomenon must be

deferred a little. In the old type of vacuum-tube apparatus, this "negative electrode resistance" resists the passage of current and must be continuously overcome; hence the use of the very high potentials of the induction coils. In the Cooper Hewitt lamp this resistance is practically eliminated after the start of the apparatus, as it is reduced to perhaps a one-thousandth part of its initial value. This fact explains why the Cooper Hewitt apparatus is much the more efficient.

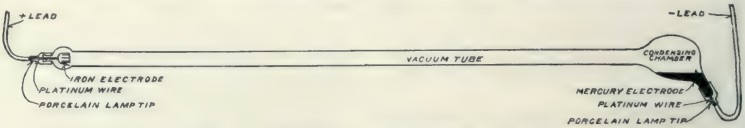


FIG. 1. DIAGRAM OF COOPER HEWITT LAMP.

Commercial Forms

The general form of apparatus as used for illuminating purposes may be seen in Fig. 1. There is a glass tube with an enlargement on one end, sealed perfectly air-tight. This tube, in the lamp shown, is about four feet long, and approximately one inch in diameter. It is made straight, as curved forms in tubes of this size are difficult to construct. The light is given principally from the tube portion of the lamp. To allow electricity to enter and leave the interior of the tube, a platinum wire passes through the glass at each end, making a perfectly tight joint, since glass will stick closely to platinum. It is necessary to have in addition two electrodes of some kind to introduce the electricity into the vacuum. One of these electrodes—"the negative," so called, that is, the electrode connected to the negative supply wire—is usually of mercury, since the negative disintegrates or "evaporates" during operation, and would ultimately disappear were it not liquid so as to be continually reformed by the flowing back of the evaporated material. The other electrode may be of mercury or any other conductor of electricity. In the lamp in Fig. 1, an iron cup about ¾ inch in diameter is used. The enlargement at one end of the tube gives condensing space for cooling the mercury that evaporates from the negative electrode, and is called the "condensing chamber."

It is necessary to use a resistance and choke coil in series with the lamp, to steady its operation and to render more constant the quantity of light produced. A diagram of the usual connections is shown in Fig. 2.

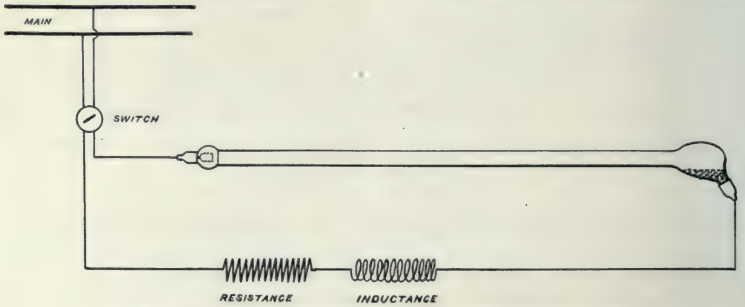


FIG. 2. DIAGRAM OF CONNECTIONS FOR COOPER HEWITT LAMP.
The lamp is started by tilting up one end.

Peculiarity of the Light

The color of the light from the lamp ordinarily appears white, with a greenish-blue tinge. When compared with incandescent lamps this blue-green color becomes intensified by contrast, and the

incandescent lamp has a strong reddish or yellow cast. When objects, however, are viewed by the Cooper Hewitt light, it is found that many have their colors modified, while some have their colors greatly altered. Black and white are not affected. Many greens and blues are brought out very beautifully, while yellows are given a greenish cast, and reds are turned black or very much darkened. This is especially true of flesh tints in the human skin, and the effect is most startling to one unaccustomed to it. The "color" is wholly taken out of the skin.

In spite of this startling characteristic, the quality of the light is very desirable for many purposes, as it is found exceptionally easy for the eyes, and one soon becomes accustomed to the color distortion. For factory lighting, machine shops, etc., the economy and the absence of shadows, which result from the long tube and the lack of exceedingly bright points, give the lamp a great advantage. Figs. 3 and 4 show two forms adapted for general illumination. These lamps operate normally on 3.5 amperes direct current from 100- to 120-volt mains. Their efficiency is about five tenths to six tenths of a watt per candle-power.

The Cooper Hewitt light has very great actinic power; that is, it is rich in the violet and ultra-violet rays which are supposed to be the active agents in photography, blue printing, etc. In Figs. 5 and 6 are shown arrangements adapted to portrait work and photo-engraving respectively. The photograph reproduced in Fig. 8 was taken by means of the light

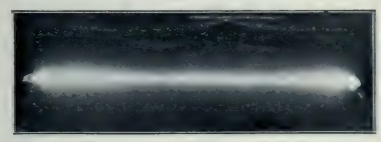


Fig. 3. Horizontal Type of Lamp in Operation.
Iron cup, positive electrode.—Condensing chamber at right-hand end.

from the lamp itself shown in the man's hands.

Starting Resistance

The Cooper Hewitt apparatus has very unusual electrical characteristics, foremost of which is its resistance to starting. As already hinted, when normal operating voltage is applied to such a lamp, no current whatever flows. This condition remains unchanged as the voltage is raised, until, finally, when the strain reaches several thousand volts, the lamp starts, whereupon the voltage may immediately be dropped to its normal operating value and the lamp will continue to run. The lamp may readily be started by a single high-potential impulse from an induction coil. It is found that the

Fig. 4. Horizontal Lamp for General Illumination.

resistance resides practically altogether at the surface of the "negative electrode." The lamp may be started by another method without the use of the momentary high potential. If by any means a metallic circuit be completed between the electrodes within the tube so that current can flow without entering the vacuum space proper, and if this circuit be then broken between the electrodes, it is found that the current is not thereby interrupted, but flows across the break through the vapor space, which is the equivalent of starting the apparatus. Some types of Cooper Hewitt lamp are started by the first method, that is, by means of the momentary high potential, which is secured from an induction coil and quick-break switch; while others are started by tilting in such a manner that the mercury used in the negative electrode flows to the positive, forming a complete conducting bridge of mercury between the

two electrodes, through which the current starts. The lamp is then tilted back to its original position. As the mercury bridge breaks, the current enters the vacuum space, and, as the mercury runs back to its proper place at one end, the current traverses the full length of the tube and is in normal operation.

Voltage of the Lamp

The lamp has also peculiar characteristics in addition to the "negative elec-

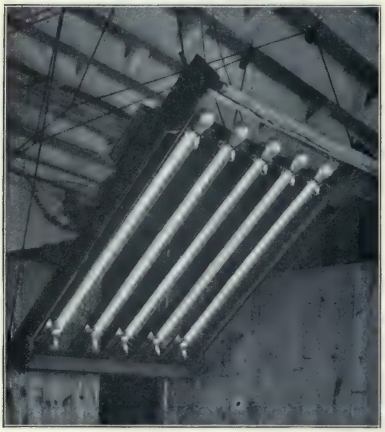


FIG. 5. SKYLIGHT OUTFIT FOR PHOTOGRAPHER'S STUDIO, TO REPLACE DAYLIGHT.

trode resistance," as the resistance to starting is called. For instance, the voltage across the lamp with currents larger than three amperes is almost constant, independent of the current flowing. This is different from an ordinary resistance, such as that found in the incandescent lamp, and resembles more nearly the resistance of a motor or battery. That is, the Cooper Hewitt lamp has no true ohmic resistance. The voltage across the lamp is not exactly constant, however; and there is a minimum voltage for each lamp occurring when the current is neither very great nor very small. This minimum voltage is the point at which the lamp should be operated for the most efficient production of light. Fig. 7 shows the relation between voltage and current in one of the more common types of Cooper Hewitt lamp. The distance of the curved line above the horizontal line indicates the voltage corresponding to any current indicated upon the horizontal line.

The reason the voltage on the lamp becomes greater with heavy currents, is that the mercury becomes excessively hot, causing considerable vaporization, which increases the resistance of the tube to the current; evidently an increase of atmospheric temperature which will also increase the temperature of the mercury, will have an effect of the same kind. It will readily be seen that this peculiar property of the Hewitt light, by which the voltage across the lamp decreases as the current is increasing, means that if the lamp be placed across constant-potential supply mains, an excessive current will tend to flow, since the more the current flows the less the resistance. It is to correct this tendency that the ohmic resistance is used in series with the lamp.

By experimental analysis it is found that the voltage across the lamp consists of three parts: The voltage drop across the negative electrode, which is nearly independent of current; the voltage drop across the positive electrode, which also is nearly independent of current; and the voltage upon the vapor column, which is high on small currents and less on lower currents. The voltage on the vapor depends entirely upon the vapor pressure—the greater the pressure the greater the voltage. These three voltages add up to make the total voltage upon the lamp.

The Modern Theory of Electricity

It is most interesting to apply to the Hewitt lamp the new theory of electricity, which has recently been proposed as a result of the work done upon cathode-ray tubes and radio-active substances. According to this theory, which has already been hinted at in THE TECHNICAL WORLD, electricity must be considered as constituted of extremely small particles, or "electrons," not over one-thousandth part the weight of a hydrogen atom. A current of electricity is a moving stream of these electrons. In traversing a vacuum they pass from the negative to the positive electrode, and are spoken of as "negative" electricity. Instead of calling them negative electricity, it is much simpler for many purposes to assume that

the old convention adopted long ago as to the direction of the electric current in a circuit is opposite to the true direction, and simply to assume that electrons are electricity and that electricity actually flows in the direction opposite to that now generally stated in the textbooks. In the cathode-ray tubes the electrons travel with enormous velocity, many thousands of miles a second.

A perfectly cold mercury vapor lamp is like a Crookes tube, except as regards its negative electrode resistance; and electricity, in passing through ether, gives no light, and meets no resistance from the vacuum other than that offered by the electrodes. Now, if the lamp becomes somewhat warm, and the mercury molecules are evaporated from the electrodes into the vacuum space, these molecules will interfere with the passage of the electrons, causing collisions which will check the electrons for the moment, heat the mercury molecules, and, further, cause them to give flashes of light (light being now supposed to be caused by the agitation of the atoms of the light-giving substance). The electromotive force existing between the electrodes will, however, urge on the electrons, which will finally, after striking other mercury molecules, reach the positive electrode. The more molecules there are evaporated from the electrodes, the greater will be the hindrance to the passage of the electrons, and the greater the voltage lost in the tube; also the greater will be the number of flashes of light given out by the vibrating particles. This action explains the increase in voltage on the lamp, which has been stated to follow an increase in its temperature; it also explains why a good vacuum is necessary in the operation of the lamp. It would take a tremendous force to drive the electrons through the same length of tube filled with air at atmospheric pressure, on account of the vast number of molecules of oxygen and nitrogen to obstruct their passage.

Color Theory

To make clear the peculiar color effects of the Cooper Hewitt lamp, it is necessary to state briefly the theory of light as it explains the color of objects.

We see objects only on account of the fact that they reflect light to our eyes. Strictly speaking, objects have no color of their own. We judge of their color by the color of the light which comes from them. Light itself may be said to have color, but objects, of themselves, do not. Daylight as well as most artificial light is a mixture of rays of all colors from red to violet in various proportions. The particular mixture found in sunlight is called white. Now, in general, objects have the power of absorbing or destroying light rays of some colors, which strike them, and of reflecting other rays. The result is that the light which comes to our eyes from these objects is

Fig. 6. Photo-Engraver's Outfit.

no longer that same mixture of colored rays that it was originally, but certain colors have been destroyed, leaving some color in excess, and the object is said to have this color.

For example, grass absorbs nearly all other colors of light which fall upon it, and reflects only the green, so that we say the grass is green. The grass itself

has no color, but only the power of reflecting green, and of absorbing all other colors that fall upon it. There are some substances which can reflect all colors; and these appear white when seen by sunlight, because sunlight itself is white. There are also some substances which absorb all colors; and these seem black, as no light is reflected from them. If, instead of daylight, we have a red light, and it should fall upon grass, the red would be absorbed, and no light would be reflected to the eye, so that the grass would appear black. Similarly, if seen by yellow or violet light, it would appear black; seen by green light, it would, of course, appear green. A white object can be seen by any color of light and has the color of this light. A black object looks the same in any light, as all colors are absorbed and none reflected by it.

All objects emit light when they are hot enough. Solid and liquid substances give out white light, a good deal like sunlight—that is, consisting of a mixture of all colors. Gases, however, are peculiar to themselves; they give only one particular color, or sometimes two, three, four, or occasionally even more particular colors, but never very many, whereas sunlight contains thousands and thousands of shades. The result is that when various objects are seen by a light from a hot gas, they have the opportunity

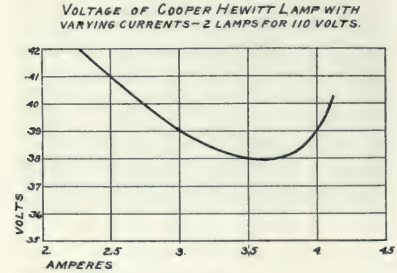


Fig. 7.

of reflecting only the particular colors existing in the light; if they cannot reflect these colors, they appear black or dark.

This explains the peculiar effect of the light from mercury vapor. This light contains four or perhaps five colors—orange, yellow, a little light blue, a darker blue, and violet. Mercury light, being a mixture of these five colors, itself looks nearly white, since there are such different colors combined. Any object which cannot reflect some one of these colors, looks black. An object which can reflect only one of the principal colors appears to have this color, so that compound

Fig. 8. Photograph of Lamp, Taken by Its Own Light.

color may be badly distorted in the light. Since there is no color in the mercury corresponding to the flesh tints of the skin, it is evident that these must appear black, which explains the peculiar ghost-like appearance of persons seen by the light.

An Analogy in Acoustics

The actions described here at some length can be more clearly understood, perhaps, by considering an analogy. Imagine each mercury molecule to be a small bell capable of giving sound of a definite pitch, and that each electron is a small steel bullet moving at high velocity; then, as each bell is struck by a bullet, it will give out a momentary sound of its own particular pitch, and the bullet will be impeded in its progress. If we have a constant force urging on the bullet, such as might be supplied by magnetism, the bullet will regain its velocity, and travel until it strikes another bell, producing another momentary sound. Since we have such a large number of bells and such enormous velocity in the bullets, there will be a tremendous

number of single sounds all of the same pitch. This will give the effect of a continuous sound, which represents the steady light from the lamp. This uniformity of pitch corresponds to the peculiar single colors given by the mercury vapor. Evidently, the greater the number of bells, the greater the amount of sound, and the greater the force required to drive the bullets through the space. This increase of force corresponds to the increase of lamp voltage with an increase of mercury pressure.

Would space permit, this theory of electrons might be carried much further to explain the properties of the lamp; but enough has been said to show how readily the theory explains its chief characteristics.

In addition to the furnishing of a new type of artificial light, the Cooper Hewitt apparatus may be applied to other useful purposes, such as the conversion of alternating current into direct current, etc. This, together with the new light thrown on the physical phenomena of the passage of electricity through a vacuum, makes Mr. Hewitt's work of surpassing interest.

A Quarter-Century of American Central Station Engineering

The Marvelously Rapid Progress in Electrical Engineering which has Revolutionized Industrial Conditions.

By R. F. SCHUCHARDT

PERHAPS few of the younger generation of men engaged in the various branches of electrical work realize that the central station industry, so large and permanent an institution of our present civic life, is barely a quarter of a century old. Marvelous, indeed, has been the progress of this industry, and its wheels of invention and development are still whirling rapidly on. No engineer who values his reputation would venture to prophesy what the next quarter-century will bring us.

Twenty-five years ago the commercial electric lamp was unknown. To-day there are in service in the United States alone nearly twenty million incandescent lamps, to say nothing of the tens of thousands of arc lamps and the few hundred thousand horse-power in electric motors. To-day nearly every city of any importance in America has an electric plant furnishing light and power to its citizens. Magnificent stations have sprung up in our large cities, representing millions of dollars in investment; and electricity is being distributed to nearly every corner of those cities. It may be of interest, then, to look back over the history of this industry, and see some of the steps by which it reached its present splendid growth.

In all the world's history of industrial progress, perhaps no chapter is more full of scientific and heroic romance than that dealing with the birth of the electric light industry. To the youth of to-day no story could give greater inspiration than that of the men who were the leading figures—the great minds and the energetic workers—during the early days of central station development. These men contributed as much toward the nation's growth as did our warriors and our statesmen. Most of them are still with

us, and are still active in solving engineering problems. It was the good fortune of the readers of the *Electrical World and Engineer* to see, in its recent 30th anniversary issue, some interesting reminiscences of these early workers, and thus have brought home to them the youthful age of the industry. It is not the purpose of this paper, however, to relate biography, but rather to treat of the more prosaic subject of the growth of the

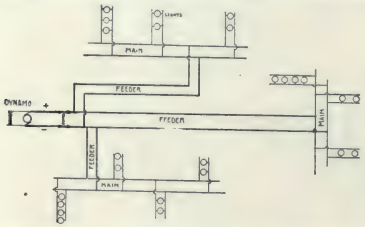


FIG. 1. CONNECTIONS OF EDISON CONSTANT-POTENTIAL SYSTEM PATENTED IN 1880.

central station from its small beginnings to the magnificent proportions of to-day.

Brush Arc System

In 1879 there was erected in Cleveland, Ohio, a series-arc system designed

FIG. 3. CEMENT-LINED IRON PIPE DUCT SYSTEM LAID IN CONCRETE.

by Charles F. Brush. The dynamo furnishing current for these lamps had been built by Brush during the preceding year. The electric arc itself had been discovered by Sir Humphry Davy in London about the year 1802, the source of current for his lamp being a battery of several thousand cells. The dynamo had not at that time, however, come into existence; so the commercial importance of the discovery was not then apparent.

From this first system of Brush's, dates the history of commercial electric light-

FIG. 2. EDISON TUBES LAID UNDERGROUND.

ing in America. As stated, the lamps on this system were all connected in series, so that the same current passed through all of them. With many lamps on the circuit, this required a fairly high voltage. The efforts of many investigators were then directed toward developing an incandescent lamp for these circuits so that the lights could be used indoors where the arc lamps would be too brilliant. In order to obtain a lamp requiring only a low voltage, which is a desirable feature in series connection, the aim was to produce a lamp of low resistance.

FIG. 4. TILE DUCT SYSTEM LAID IN CONCRETE.

Edison Constant-Potential System

The master mind of Thomas Edison soon saw that a series system with high voltage on each line would never become commercial for general house lighting; so he set about to design a system which should properly meet the required conditions. On February 5, 1880, he patented a constant-potential system consisting of feeders and mains, with the load connected in parallel, or multiple arc, between the two wires forming the positive and the negative conductors, as shown in Fig. 1. How well this succeeded is evidenced by the present almost universal

FIG. 5. CONNECTIONS OF 3-WIRE D. C. SYSTEM.

use of this system of connection. A low-resistance lamp would obviously not do on a constant-potential circuit; and Edison, therefore, had first to develop a high-resistance lamp. His success in this is well-known history. His patent for the lamp is dated November 4, 1879. In December of that year he had a number of these lamps on exhibition at his laboratory in Menlo Park, and the following year he equipped his house and grounds with the lamps. The newspapers of the

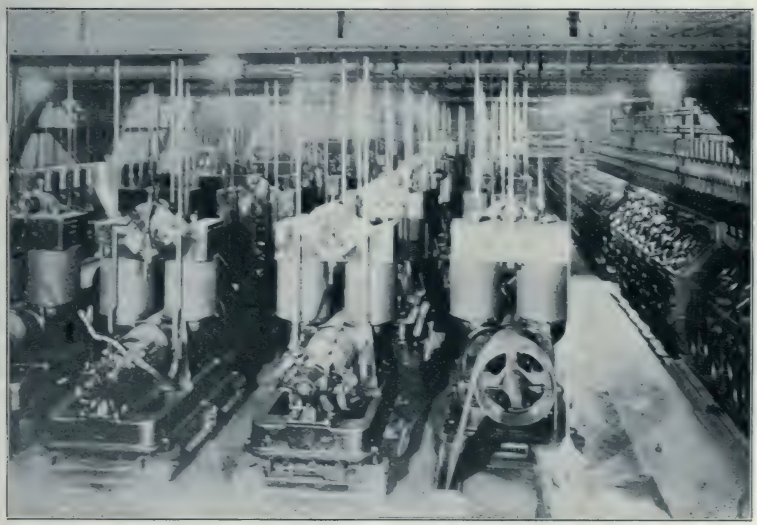


FIG. 6. DYNAMO ROOM, OLD ADAMS STREET STATION, CHICAGO EDISON COMPANY.

time were filled with accounts of what the "Wizard of Menlo Park" had accomplished, and visitors flocked to the town in great numbers to see the lights.

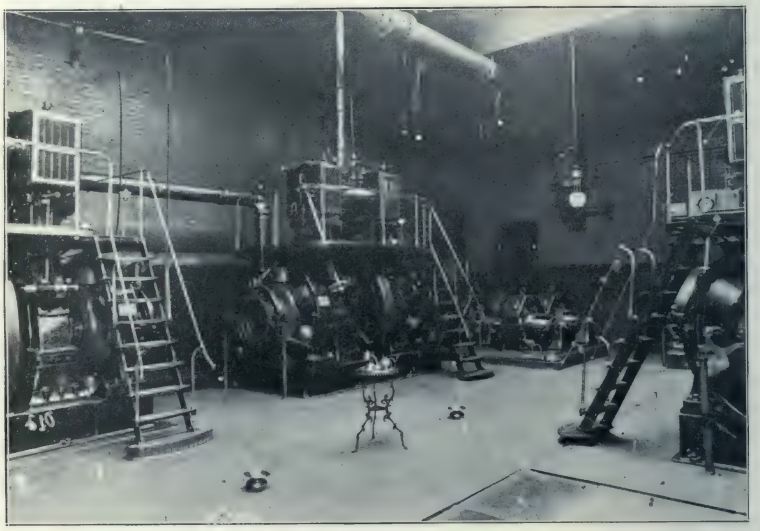


FIG. 7. NORTH SIDE STATION, CHICAGO EDISON COMPANY, CLARK AND OAK STREETS.

The first Edison plant for the public supply of current was located at Appleton, Wis., where, in 1881, was installed one of the first of the lanky bipolar dynamos, connected by a belt to a water wheel in a little wooden shed. The first central station for general distribution of current to incandescent lamps was started January 12, 1882, at Holborn Viaduct in London, England. The second and the third Jumbo dynamos (so named because of their bulk), built by Edison in America, furnished the current for this system. They weighed twenty-three tons each, and had a combined capacity of 3,000 lights. The first of these machines built by Edison was sent to the Paris Exposition of 1881. By October, 1882, the Edison Manufacturing Company had installed in all 123 plants, with a total of about 22,000 lamps.

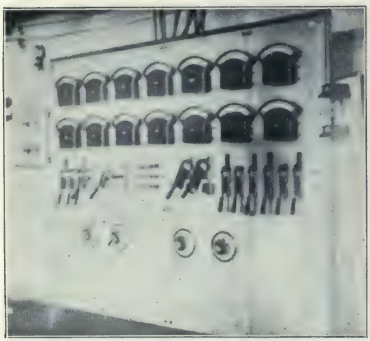


FIG 8. SWITCHBOARD OF EARLY D. C. STATION.

The Edison Tube

During this time Edison's attention had been directed toward laying out a system for the city of New York. In such a city it was desirable to have the system underground. Accordingly, the Edison tube was designed. This consisted of two half-round copper bars laid in iron pipe in lengths of about twenty feet, and insulated by means of a tar compound. In Fig. 2 are shown some Edison tubes laid underground. The couplings joining the pipe sections can be clearly seen. While there are still many miles of these tubes giving good service, all new underground work has

for some years been done with lead-covered cables drawn into ducts laid in the streets, the connections being made in manholes. Fig. 3 shows a duct system made of cement-lined iron pipes laid in a bed of concrete; and in Fig. 4 is a similar duct line made of tile. The short sections of the tile can be seen lying at the side, while a manhole under construction is shown in the foreground.

The Edison Electric Illuminating Company of New York had been organized, and the historic station on Pearl Street was built. On September 4, 1882, the station first sent out current to its 59 customers, with a total connected load of 1,284 lamps. The dynamos, of which there were six, were of the Jumbo type, each of 75 K. W. capacity, direct-connected to Porter-Allen engines of 200 H. P. each, running at a speed of 350 revolutions per minute. The success of this station led to the establishment of others, and in 1883 a few Edison stations were started in Europe. The alternating-current station did not appear until later.

Three-Wire Direct-Current System

Late in 1882 Edison made a series of experiments with a view toward a more economical distribution system, and he then devised the well-known three-wire system, in which two generators are connected in series, and a conductor is connected to their common join, and run out into the system as the neutral wire. This is illustrated in Fig. 5. By connecting the lights so that the load on the two sides of the system is nearly balanced, a saving of about sixty per cent was effected in the amount of copper necessary to transmit the same energy. This is due to the fact that, in the three-wire system, the current is transmitted at 220 volts instead of at 110, thus requiring for the same number of watts only half as many amperes; and therefore a smaller wire can be used. If the load on the two sides of the system is not balanced, the difference between the current in the positive conductor and that in the negative will come back to the dynamos over the neutral wire. Dr. John Hopkinson,

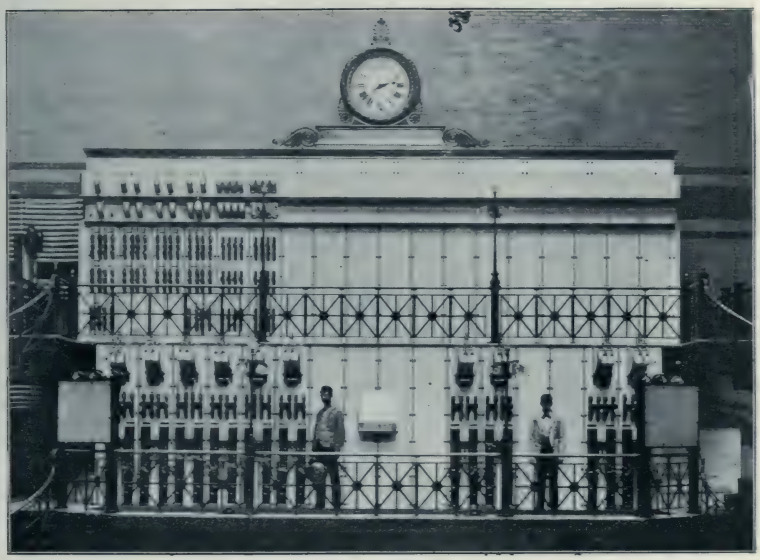


FIG. 9. SWITCHBOARD AT HARRISON STREET STATION.

A comparison with the early form of switchboard, illustrated in Fig. 8, shows advance made in design in 1893.

in England, and Werner von Siemens, in Germany, devised similar systems at about the same time.

It was not until 1884 that electric motors were first used in New York; and using 220-volt motors on the Edison system, connecting them to the two outer mains instead of between one outer and the neutral (110 volts), as had heretofore been done.

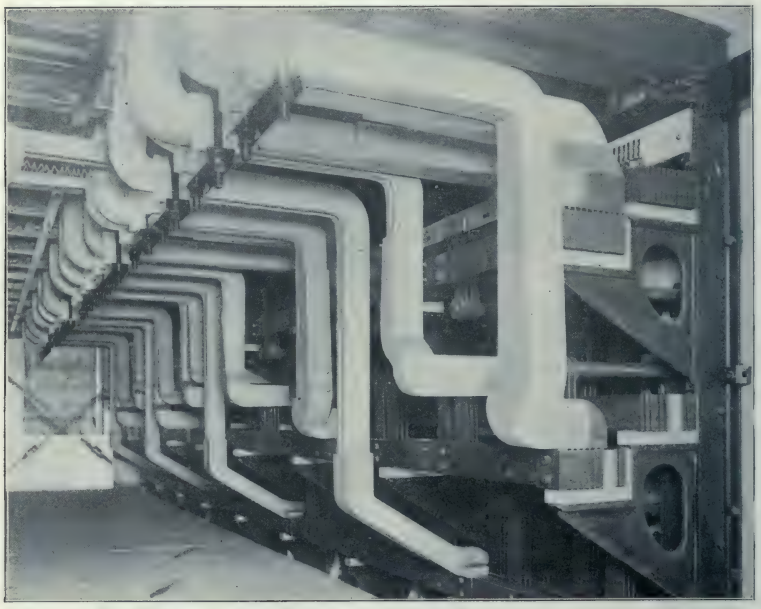


FIG. 10. REAR OF GENERATOR GALLERY, HARRISON STREET STATION SWITCHBOARD.

the arc lamp designed for parallel connection on the constant-potential circuit was not introduced until 1889. The success of the constant-potential arc lamps made it possible for central stations to do all classes of business with one system of distribution—which was an important step in the march of progress. In 1890 the Duane Street Station was built in the heart of the Edison system, with a total engine capacity of 11,800 H. P. in direct-connected units.

In Boston the Edison Electric Illuminating Company was organized in December, 1885, and the first station was started in February of the next year, using the Edison three-wire system of distribution. In 1887 a second station was built to take care of the load in another section of the city. Here, for the first time, was adopted the method of

The Edison Companies

The good financial showing made by this company led to the formation of Edison companies in many other cities, among the largest of which were Chicago and Philadelphia; and to the building of two up-town stations in New York. The original plant of the Western Edison Electric Light Company (now the Chicago Edison Company), a view of the dynamo room of which is shown in Fig. 6, was built at 139 Adams Street in 1887, and contained at first eight 100-K. W. Edison bipolar dynamos belted to four 250-H. P. engines located on the floor below. In 1891, additional dynamos and engines were added, until the total capacity reached 3,400 K. W. In the summer of 1892, the big station at Harrison Street, representing the most modern central station engineering of the

time, was started; and the next year the Adams Street Station was dismantled. The center of distribution, however, was kept at Adams Street, the current generated at the new station, about 3,000 feet away, being sent to this center over a trunk line consisting of twenty-eight Edison tubes and cables with a total sectional area of 66,000,000 circular mils. Of this, 9,000,000 c. m. of section was used for the neutral conductors, leaving 28,500,000 c. m. for each of the outsides, *i. e.*, for the positive and the negative.

In its onward march the Chicago Edison Company absorbed a number of plants, chief of which was that of the Chicago Arc Light & Power Company, located at Washington Street and the river. The systems operated from this station at that time consisted of series arcs, 500-volt direct current for power, and some 133-cycle 1,000-volt alternating-current lines. In 1894 there were added the Wabash Avenue Station near 27th Street on the South Side, with an Edison three-wire system and some series-arc lines; and the North Side Station at Clark and Oak Streets, which consisted solely of Edison generators connected to the usual three-wire system (Fig. 7). The switchboard of an early direct-current station is shown in Fig. 8. A comparison of this with Fig. 9, which is a view of the board at Harrison Street Station, shows the advance made in switchboard design in 1893. Fig. 10 is a back view of the generator gallery of this board, and shows the heavy copper bus bars; while Fig. 11 shows the same switchboard as it is to-day. The addition shown at the right is for the alternating-current generators, one of which, of 3,500-K. W. capacity, is shown in Fig. 27 the A. C. side of the double-current generators, and for the 9,000-volt transmission lines. Fig. 12 is a cross-section of the engine and boiler rooms at Harrison Street Station, and Fig. 13 shows one of the 1,200-H. P. Southwark engines direct-connected to two 115-volt 400-K. W. generators. One of these dynamos connects with the positive, and the other with the negative, of the three-wire system.

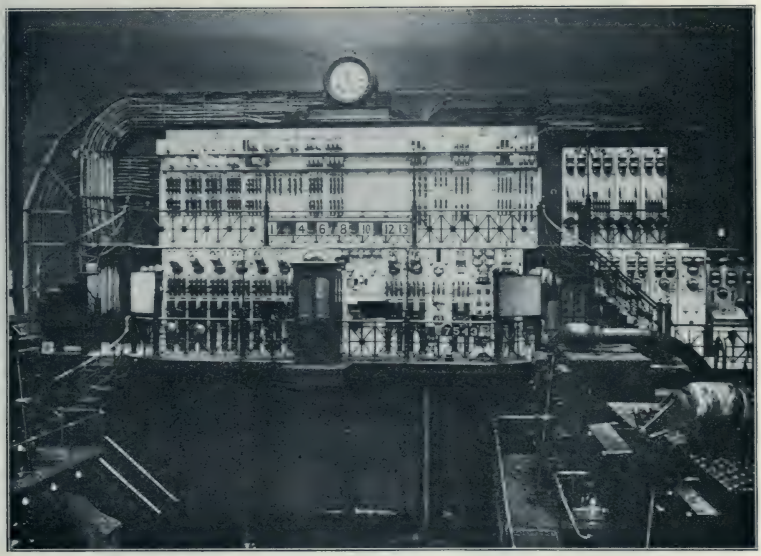


FIG. 11. SWITCHBOARD, HARRISON STREET STATION, AS IT IS TO-DAY.

Conservative Brooklyn waited to see what success was met by electric light

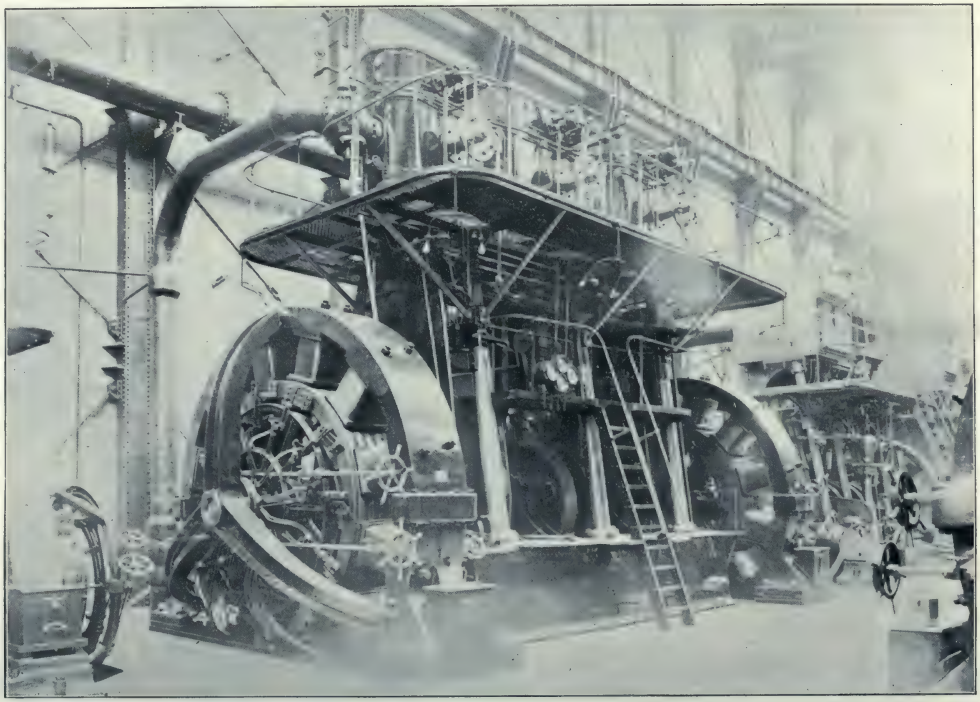


FIG. 13. A 1,200-H. P. SOUTHWARK ENGINE DIRECT-CONNECTED TO TWO 115-VOLT 400-K. W. GENERATORS.

Harrison Street Station, Chicago Edison Company.

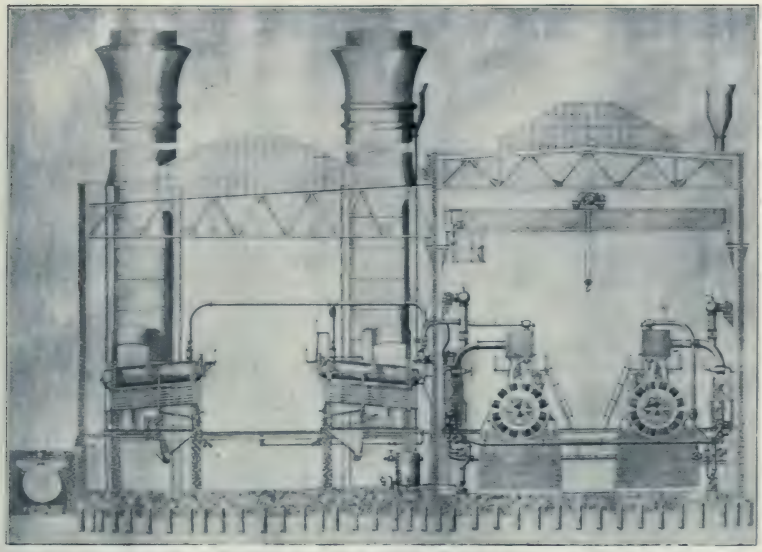


FIG. 12. CROSS-SECTION OF ENGINE AND BOILER ROOMS, HARRISON STREET STATION.
Showing 1,200-H. P. Southwark Engines Nos. 7, 8, 9, and 10.

companies in other cities before its capitalists embarked on such enterprises, but in 1889 that city was added to the list of those having a central station for the production of electricity. In that year the Edison Electric Illuminating Company of Brooklyn built its first station on Pearl Street, and started operations with a load of 6,600 incandescent lamps connected to the system. The dynamos used were four of the Edison bipolar type of 100-K. W. capacity, each two of which were belted to a 250-H. P. cross-compound engine and were connected to an underground Edison three-wire distribution system. In 1893 the station was remodeled, larger dynamos were introduced, and direct-connected to vertical cross-compound-condensing engines.

(To be continued)

The Main Picture at the Louisiana Purchase Exposition

Festival Hall, The Colonnade of States, The Cascades.

By CALE GOUGH

THE MERE CONCEPTION of an exposition demands that it have some distinctive feature that will stand out paramount to all that is admirable surrounding it. The Columbian Exposition had its Peristyle; Buffalo, her electric tower; Paris, her Cascade. But the broader plans of the Louisiana Purchase Exposition required that this central feature should in itself be broad. The Peristyle at Chicago was distinctive from an architectural standpoint; the center of the Pan-American Exposition was electrical; the Cascade at Paris, as an artistic feature, was certainly admirable. To combine all of these into one, and to add even more, if possible, was the first task of the architects and engineers of the Louisiana Purchase Exposition. How well they have succeeded, must be decided by each visitor in his appreciation of the "main picture" of the Exposition.

Festival Hall, with its lofty dome; the Colonnade of States, flanking it on either side; and the three separate Cascades in the foreground, converging towards a common center, complete this picture.

Festival Hall

Festival Hall, itself the center of the panorama, is, from an engineering standpoint alone, a remarkable structure. The bronze figure surmounting the dome is more than 200 feet above the level of the floor. The dome itself has a diameter of about 140 feet at its base. The erection of a steel structure of these dimensions would present no unusual problems; but in the whole of Festival Hall, timber construction was used; and this fact alone makes the building most remarkable.

FESTIVAL HALL AND COLONNADE OF STATES.
From Head of Grand Basin.

To the rear of the hall, the circular form is broken by an addition of less lofty height, containing the immense stage and adjacent rooms. The proscenium arch of this stage is probably the largest in existence.

Festival Hall is intended primarily for musical performances on a scale never before attempted. The whole interior has been carefully planned with the spe-

cial idea of securing the best acoustic effects.

The largest pipe organ in the world occupies the rear of the stage, requiring for its installation a space 63 feet long, 30 feet deep, and 50 feet high. In the case of this organ, figures assume vast proportions. With its 10,059 pipes, it is

INTERIOR OF FESTIVAL HALL.
View from the Stage, showing portion of Stage, Auditorium, and Gallery.

possible to produce more than 17,000,000,000 tonal effects. This means that were a different tone drawn every second, five centuries would be required to exhaust the total range of the instrument. The largest of the pipes is of wood, being 32 feet long and 22 x 27 inches in cross-section. Compared with this, the smallest pipe is a mere pigmy, as it measures only three-sixteenths of an inch in

MOVABLE KEY-DESK OF PIPE ORGAN IN FESTIVAL HALL.
The Cable of Electric Wires, its only connection with the Organ proper, is shown at the right.

diameter and is three-fourths of an inch long, its weight being less than half an ounce.

The instrument can be operated from either of two consoles or key-desks. One of these is provided with an automatic playing attachment which makes possible the rendition of music entirely beyond the range of human fingers.

The other console is operated in the usual manner. Its only connection with the main organ is a cable of electric wires. This makes it possible to set the console on any part of the stage within the range of the cable.

The organ was constructed specially for the Convention Hall at Kansas City, Missouri, whither it will be removed at the close of the Exposition.

The Cascades

How the great volume of water which pours over the Cascades is raised to the height from which it falls, will probably

STAGE AND PROSCENIUM ARCH IN FESTIVAL HALL.
The Pipe Organ, in course of erection, is seen in the rear.

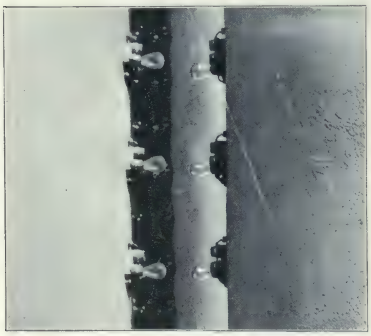
be a perplexing question to many. Three centrifugal pumps installed under the Cascade to the east, each capable of raising 35,000 gallons per minute against a head of 160 feet, supply this water. The design of the Cascades calls for 90,000 gallons per minute. The amount can better be appreciated when it is stated that the average rate of consumption of the entire city of St. Louis does not exceed this.

The pumps are of the turbine type, revolving at a speed of 325 revolutions per minute. This speed makes it possible to connect to them directly, without intermediate gearing or belts, the electric

EARLY TYPES, SHOWING EVOLUTION OF THE LOCOMOTIVE.
Palace of Transportation.

motors operating them. These motors are supplied with power from the electric plant in Machinery Hall, the source of practically all the electricity used on the Fair grounds.

With a city waterworks or pumping



COLUMNS OF THE COLONNADE OF STATES.
Showing Lights placed on Inside of Columns. Only the white globes are in place, the other two sockets in each group being for colored lamps.

plant, we usually associate the idea of large and ponderous engines built high in the air, and surrounded by polished railings and stairways. The extreme simplicity of this Cascade plant, the only movable part that is visible being the shaft of the motor, is indeed striking when we remember that the capacity of the plant is many times that of the complicated installations usually seen.

The water from which the supply for the pumps is drawn, comes largely from the condensers of the engines in Machinery Hall. Two 24-inch vitrified pipes lead from the condensers to the lagoon. These make connection with a wood tunnel measuring six by six feet, which runs under the Grand Basin to the left spillway, where the pumps are located. By this means the Cascades are made to serve as a cooling tower for the engines.

This arrangement results in a rather peculiar cycle of events. The mechanical energy supplied the pumps is absorbed from the water, which, in turn, absorbs some of this energy when it is passed through the pumps.

The centrifugal pumps would in themselves give a comparatively steady flow of water; but, to assure this, they are made to discharge into a tank of 100,000 gallons' capacity, upon which is main-

tained a constant air pressure of sixty pounds.

From the level of the Grand Basin to the bowl which forms an ornamental feature of Festival Hall, and out of which the water of the central Cascade falls, there is a difference of level of 154 feet. Pouring oven the curved edges of the bowl, the stream makes a series of descents to a large basin about thirty feet below; thence it passes under a promenade to the top of the Cascades proper.

Water of Main Cascade, Issuing from Bowl.

Here it begins its descent over the nine successive ledges, to the Grand Basin below. At each ledge, fountains on either side of the waterway, formed of ornamental figures, add their streams to the flow.

Ornamental flower beds flank the waterway on each side. Beyond these are the broad stairways leading to Festival Hall. At every turn, or wherever opportunity was given, have been placed allegorical or historical figures in staff, until the whole hillside is one assemblage of statues.

It is difficult to realize, as one ascends these seemingly solid stone stairways with their massive balustrades and figures, that he is in reality treading on a wooden structure between which and solid ground intervene several feet of space. The waterway of the central Cascade itself is ingeniously constructed on piles. A layer of two-inch boards, another of one-inch flooring, in turn covered with a heavy duck cloth well painted, are all that separate the water from the vacant space underneath.

Illumination Effects

In the illumination of the Cascades, Festival Hall, and the Colonnade of States, more than 20,000 incandescent lamps are used.

The scheme of electrical illumination is as efficient as it is novel. Three separate systems of wiring for incandescent lamps have been installed. One of these has been supplied with globes of clear glass, another with emerald, and the third with amethyst globes. The three systems being independent, either one, two, or all three sets of globes of one color may be lighted simultaneously at varying voltages and consequent varying intensities. The colors have been so selected as to blend harmoniously; and the varying shades and tints that can be given to the whole picture by different combinations are almost innumerable.

On the Colonnade of States, the globes themselves are not visible, being placed between and to the rear of the columns. By so hiding the intensity of the lamps themselves, a mellow or subdued effect is obtained, causing the columns and statuary to stand out in relief, and giving depth to the whole picture.

The main Cascade is lighted by a row of globes just underneath each of the nine ledges over which the water falls. The water, in passing over, takes the color of the globes, on the same principle as in the case of the ordinary electric fountain.

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¶ A shirt-front is something to be "studded."

¶ To remove paint, sit down on it before it is dry.

¶ A cucumber does its best fighting after it is down.

¶ A man who does not think as you do is apt to be pig-headed.

¶ It takes sand to organize and carry on a successful sugar trust.

¶ There is a good deal of socialism and anarchy about a mince pie.

¶ In the bright lexicon of speculation, there is nothing so uncertain as a "sure thing."

¶ The favorite hymn of the pious electrician: "I am going home to dy-na-mo."

¶ The Englishman who said that hugging was 'armless, was wrong; it is 'armful.

¶ There is no reason in the world why a "baby show" should not be a howling success.

¶ A man who does not know anything is pretty sure to tell it the first chance he gets.

¶ The wise man who has anything to say to a mule, says it to his face.

¶ A successful man roots, while his unsuccessful brother stands around and squeals.

¶ Quit making good resolutions, and get down to business.

¶ If a man is tongue-tied he can never hope to become a pugilist.

¶ The more a man talks about himself, the less use he has for the truth.

¶ What a good many towns need is a 9 o'clock curfew for married men.

¶ One idea of Hades is that of a place where every man is allowed to boss.

¶ About the time the average man succeeds in developing a theory, it explodes.

¶ No man need hope to pass through the pearly gates on the strength of the epitaph on his tombstone.

¶ After a young man's mustache becomes heavier than his eyebrows, his knowledge of the world begins to decrease.

¶ It is a waste of time for a father to attempt to train up his son in the way he should go, if he doesn't keep in the middle of the same road himself.

Where the Blame Lies

PEOPLE OF THE UNITED STATES have been appalled by the following of one great calamity close upon another; and the sorrow of it all is mingled with shame when it is realized that these calamities would have been averted if people had done their duty. The Iroquois theater fire in Chicago, and the *General Slocum* disaster in New York, have been the most striking recent examples of American laxity in the carrying out of laws intended for the insurance of the safety of the public. And now the loss of the steamer *Norge*, in Danish waters, involving the sacrifice of approximately a thousand lives, seems to show that Americans are not the only offenders in this respect.

The nailing down of windows that are supposed to be opened automatically in case of fire; the providing of rotten life-preservers, and the loading down of lifeboats with useless material so that a period of half an hour is required to launch them in case of accident—these are all bits of criminal carelessness and neglect which reflect upon the municipal and civic authorities who are the executives of the trust of the public safety.

But the responsibility of safeguard does not stop with the executives. The laws we have, good as they are, and effective if enforced, would be much better if intelligently revised and made exact to fit their ma[illegible]t functions. The knowledge of wi[illegible]t precautions the laws shall require, what construction the houses and the boats must have, and what activities shall control their filling, emptying, and protection, must come from men *trained in constructive effort*. The problem of the public safety is for *them* to solve.

The Business Engineer

THE FACT has been growing more and more obvious, that the engineer who couples with his technical qualifications a practical knowledge of business, an ability to do things in a business way, is likely to make a fuller success of his profession than the one possessed of technical training only. It is true that many highly trained specialists and professional men handle their business affairs in an almost childlike way; and, when the professional man happens to be an engineer, this deficiency is all the more grave because, after all, the successful engineer is the man who can properly apply technical knowledge to the furtherance of commercial ends. Here, then, is a plea for the "business" engineer in the sense of the engineer who is a capable business man.

The term "business engineer" has recently been used in a somewhat different sense. The University of Brussels has announced that it will bestow the degree of "Business Engineer" upon the graduates of its newly established Department of Commercial Studies. The business engineer in this sense is to do for commercial processes—for the perfecting of business methods in accounting, in the controlling of men, the handling of goods and their distribution throughout the world—what the various engineering professions already have done toward perfecting the methods of manufacturing and transportation. In this sense the business engineer will stand in a professional and technical class by himself, but ranking with engineers of civil, mechanical, and electrical specialization. Success to the business engineer!

The Value of Biography

STORIES ABOUT MEN and things they do have made up most of the literature of all times, to say nothing of the songs and sagas that were sung and told but never written. To be worthy of a story which will live, a man needs to be something a little above the dead level of mediocrity: the hillock drops into the receding plain more quickly than the mountain. Biography owes interest to the ever-ready questions: What was he that I am not? What did he do that I may not? "What help had he that I may not get?" Those who wonder at the frequent appearance of biographical sketches of successful men, might do well to put these questions to practical test. Perhaps a desire for self-betterment may induce an interest heretofore lacking.

The Technical Man and Irrigation

TO THOSE not familiar with the subject, Mr. Mitchell's article on irrigation opens up an impressive vista of possibilities. The reclamation of vast tracts of arid and at present utterly desolate lands, converting them into veritable garden spots, involves problems of the greatest industrial, economical, and political importance, the magnitude of which increases as one ponders. That the technical man will play an ever-increasing part in the solution of these problems, is self-evident in this day of engineering achievement. The fallacy that all of the good opportunities in the field of engineering and applied science are now matters of the past, will never find a more complete refutation than in the present irrigation needs in this country. The civil engineer must survey unexplored tracts, bridge and dam heretofore unconquered streams, and convey the imprisoned waters in canals, ditches, or flumes to their final peaceful destination; the electrical and mechanical engineer

must find means to use the water thus stored up by his brother, converting its potential energy into electrical current, which, transmitted to a distance, will furnish power, light, and comfort to homes finally reached and beautified by the water itself. The manufacturer at large must supply not only the equipment required by the various engineers in the field, but the necessities of the entire community which is made to exist and flourish by the work of the engineers. There is an inspiration for the ambitious man in the boundless opportunities for achievement afforded by national irrigation.

The Smoke Nuisance

A VOLUME of soft coal smoke issuing from a power house stack, carrying soot and smut over all the neighborhood, has no more reason for its existence than an extra tail on a dog. Black smoke pouring forth from a factory chimney is an indication of bad firing and a positive waste of fuel. Some years ago, clouds of black smoke issuing from factory chimneys was a sign of prosperity —to-day it is generally a sign of bad management.

The smoke nuisance may be overcome by good combustion, "a sustained high temperature, enough air, and a thorough mixture of gases." A good illustration is afforded by an ordinary kerosene lamp, which will smoke unless proper combustion is secured. Petroleum, like soft coal, is composed largely of carbon and hydrogen, and the problem is the same in each case. No quarter should be shown by municipal authorities to the authors of the smoke nuisance.

Civilization and War

"WAR," said General Sherman, "is hell," and we have no doubt the average Russian will endorse the General's forcible definition.

Japan has surprised the world. The present war is simply another demonstration that the nations of Europe are living on the memories of past military glory. Civilization destroys a nation's power to wage successful warfare. Civilization may invent smokeless powder, battleships, rapid-firing guns, but its attendant luxuries are weakening those muscular and nervous attributes indispensable to the making of a first-class fighting man.

The average private soldier of the European nations to-day is inferior to the average private soldier of the past. Talk as we may, what is wanted in a private soldier is physical strength, disciplined into a quick-acting machine capable of much endurance and free from those camp-followers of higher civilization—dyspepsia and nervousness.

Japan has just arisen out of barbarism; the enervating indulgences of civilization have not yet had time to start a dry rot in the lives of her plain people. As a world power she has the physical vigor and alertness of semi-barbarism. The other nations of Europe would fail as Russia has apparently failed had they attempted a similar task.

The United States Patent Office

MR. THOMAS A. EDISON, the prominent inventor, is stirring up the Patent Office with charges of incompetency. The *New York World* states the case as follows:

"Mr. Edison's specific charge is that while his application for a patent on a device to be used in connection with a motor-carriage storage battery was pending, the examiner in the case permitted a rival inventor to withdraw his own application and to insert in the specifications claims covered by the Edison patent. There is a fixed belief in the minds of many disappointed patent-seekers that it has at times been possible for favored persons to learn the general features of patents in advance of their issue and to defeat or invalidate them by appropriating their main points. This belief may be merely the figment of over-active imaginations. But it has long existed, and the Edison inquiry will serve a good end as either confirming or temporarily quieting it. The limited monopoly which the law grants the inventor is held to be a legitimate stimulant to discovery and reward for valuable inventions. Its underhand infringement as alleged is a peculiarly despicable form of fraud."

The Machinery of Modern Warfare

Some of the Death-Dealing Devices, Transportation Methods, etc., that are being Tested in the Present War in the Orient

By RUTLEDGE RUTHERFORD

OUT OF THE DUST and smoke and heartaches of the war now raging in the Far East, are arising novel mechanical inventions and resultant new military regulations that are to shape the future destinies of nations. Success in this, as in all past wars since brute force ceased to be the one supreme factor, depends as much on the effectiveness of the machines of death employed as on the competency of leaders or the strength of human forces, though all, of course, must play their respective parts. Were this a day of earlier history, when men fought hand to hand and when brawn and muscle made men and nations great, the Russians might easily conquer the Japanese; but, quite to the contrary, this is a day of mechanics, and, instead

RUSSIAN TROOPS MARCHING ON THE MANCHURIAN RAILWAY.

of the arm that can strike the hardest blow, it is now the brain that can devise the most destructive weapons and evolve the most alert and intelligent strategy, which wins out. The Japanese soldier looks like a pigmy beside the brawny Russian; but the gun carried by the wiry little Jap shoots as far and as effectively as the Russian's gun, while a Russian is easier to hit than a Jap, because he is larger, and a bullet will kill a Russian as readily as it will kill anyone else.

The Arisaka Guns

The recent success of the Japanese artillery on the Yalu is attributed largely to the heavy Arisaka battery, a secret invention. In an interview the inventor said that these guns would nulify the ac-

GUN ON HWANG-CHIN-SANG FORT.

tion of the Russian guns of long range, which would be useless without telescopic sights.

The Arisaka rifle, one of the makes of small arms used by the Japanese infantry, is also very powerful. It is of small caliber, great initial velocity, and very low trajectory, and is essentially modern. The Russian magazine rifle is of the old model. The rate of fire of the two weapons is the same; but as regards accuracy, the Japanese rifle is said to be perceptibly inferior to the Russian—more so in long distance and in wind—a condition explained by the fact that the Japanese cartridge weighs only two-thirds as much as the Russian cartridge. The

chief difference in the two rifles lies in the trajectory.

The Midgi Rifle

Another rifle of the Japanese is called the Midgi. It is a magazine gun holding five cartridges, and was invented by a Japanese officer. Part of the troops still retain the Murata rifle, used in the China-Japan war of 1894-95.

JAPAN
THE ARISAKA RIFLE
THE WEAPON IN USE IN FIRST LINE OF THE JAPANESE
ARMY. DESIGNED IN 1897 BY COLONEL ARISAKA WHO COMBINED ALL THE LATEST KNOWN IMPROVEMENTS. IT HAS A VERY SMALL BORE 6m/m 5 IN WHICH IT RESEMBLES THE ITALIAN MODEL OF 1891
SWORD BAYONET
IT HAS A CENTRAL MAGAZINE OF THE MAUSER TYPE. ITS BREECH IS ANALOGOUS TO THAT OF THE RUSSIAN BUT DIFFERS IN HAVING THE LEVER OF THE MECHANISM PLACED FURTHER BACK
IT WORKS IN SAME FASHION AS THE RUSSIAN RIFLE BUT THE CARRIER IS SIMPLER. IT HOLDS 5 CARTRIDGES AND FIRES A NICKEL PLATED BULLET OF HARDENED LEAD WEIGHING 10 GR
ITS INITIAL VELOCITY WHICH IS VERY GREAT IS 720 METRES
THE CARTRIDGE WHICH IS VERY LIGHT, ONLY WEIGHS 22½ GRAMMES. IT CONTAIN A CHARGE OF 2 GRAMMES 14 OF A SMOKELESS POWDER MANUFACTURED IN JAPAN (TABASKI POWDER) THE GUN WITH ITS SWORD BAYONET WEIGHS 4 KILOS 335 AND ITS LENGTH IS 1 METRE 66. IT HAS PRACTICALLY NO TRAJECTORY CURVE UP TO RANGE OF 690 METRES.
A. RIGHI FISHER

MECHANISM OF JAPANESE SMALL ARMS.

Russian Infantry Weapons

The Russian infantry weapon is what is known as the "three-line" rifle of 1891. It is manufactured in the small-arms factories conducted by the Russian Government. The weapon is very powerful, but it lacks improvements that add to the convenience of handling as in the case of more modern arms.

In several engagements it has been observed that the Russian infantryman did not wear a bayonet scabbard, but kept his bayonet fixed at all times, and his rifle was never out of reach of his hand.

Russian Arms Factories

The methods of conducting the Russian small-arms factories are interesting. The largest of these factories are at Tula, Sestrorietsk, and Ijevsk. The Tula and Sestrorietsk factories were founded by Peter the Great. At the head of each factory is a director, who is assisted by a sub-director in technical matters. The director of the important Tula factory is a general of field artillery. He superintends the administrative details, and is assisted by a council composed of several persons with a field officer at their head, which council attends to all technical questions of fundamental importance. The majority of the mechanical sections of the factories are in charge of active artillery officers, a small part being in charge of civil officials taken from the technical institutions of the artillery. In Russia, artillery officers alone are considered capable of directing factories of military stores. Only in cases of necessity are efficient engineer officers admitted, and that to subordinate positions, in the factories. The directors of the mechanical sections are responsible, not only in financial matters, but also in regard to the workmanship of the war material manufactured under their supervision. They are, as a matter of course, subordi-

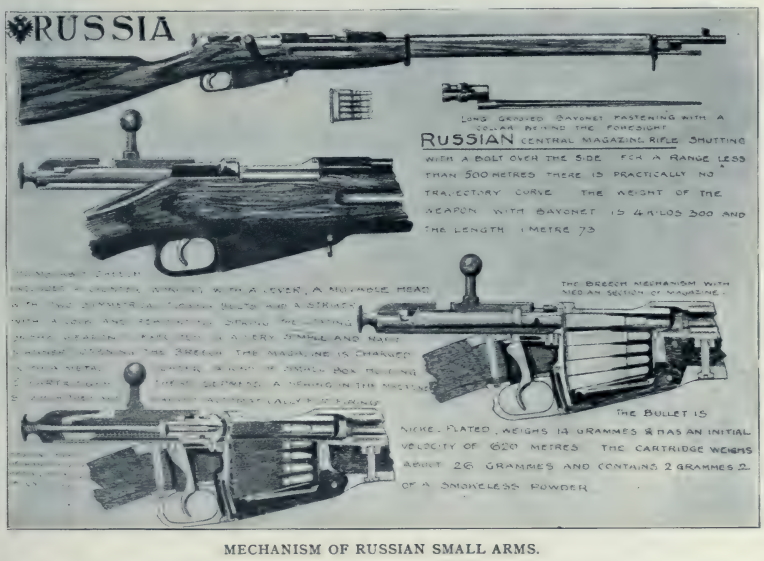
nate to the director and sub-director of the factory. A board of control and inspection, consisting of field and subaltern officers, is assigned to the factory, without being subordinate to it. This board takes charge of the manufactured material, and a considerable number of armorers are detailed to it.

Apart from the factories themselves, but belonging to them, are hospitals for sick and injured workmen, sanitariums, children's schools, coöperative societies, and training schools. These latter also serve for the training of personnel to supply vacancies of armorers at the front. The course lasts four years. In the training schools the sons of workmen are taught a practical trade, at which they can afterward work in the factory itself.

new field guns. At the Poutilov Works, southeast of St. Petersburg, has just been constructed a rapid-fire gun that is attracting considerable attention. This new weapon is built after General Englehart's design. It is of 3-inch caliber, and replaces the light 86.9 mm. field gun and the heavy 106.7 mm. gun. It weighs 393 kilograms (865 pounds). All the Russian batteries are believed to have been supplied with it. Such a rearmament was very expensive in so large an army. Some 7,000 guns were required, and the expense is estimated at $92,000,000.

Japanese and Russian Cavalry

Russia's one superiority over the Japanese is held by many to consist in her cavalry. This organization, composed


RUSSIA
LONG GROOVED BAYONET FASTENING WITH A SQUARE BEHIND THE FORESIGHT
RUSSIAN CENTRAL MAGAZINE RIFLE SHUTTING WITH A BOLT OVER THE SIDE FOR A RANGE LESS THAN 500 METRES THERE IS PRACTICALLY NO TRAJECTORY CURVE THE WEIGHT OF THE WEAPON WITH BAYONET IS 4·8 KILOS 300 AND THE LENGTH 1 METRE 73
THE BREECH MECHANISM WITH MID AN SECTION OF MAGAZINE
THE BULLET IS NICKEL-PLATED, WEIGHS 14 GRAMMES 8 HAS AN INITIAL VELOCITY OF 620 METRES THE CARTRIDGE WEIGHS ABOUT 26 GRAMMES AND CONTAINS 2 GRAMMES 2 OF A SMOKELESS POWDER

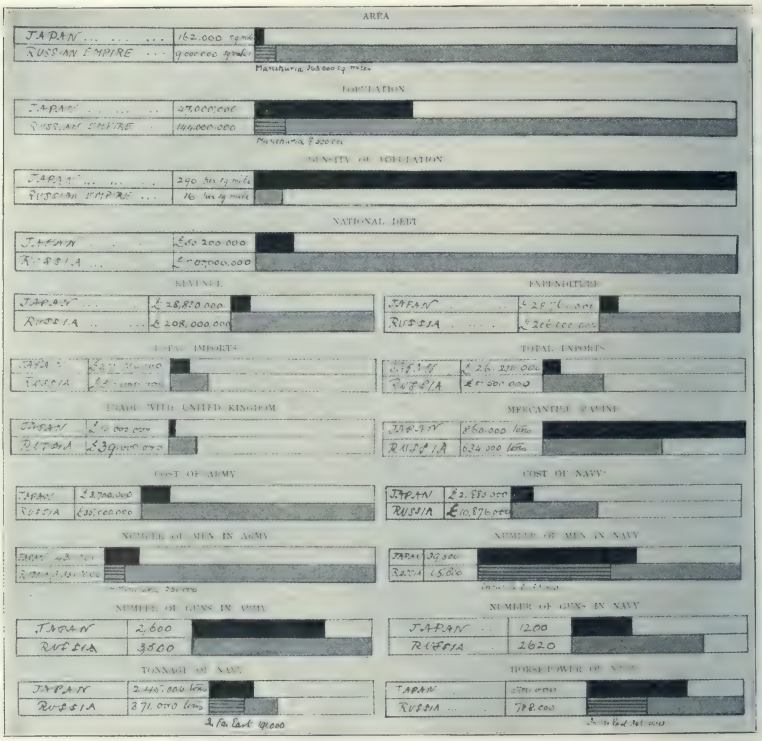
MECHANISM OF RUSSIAN SMALL ARMS.

Almost all the pupils of these schools enter the arms factories as workmen after completing their preliminary training. All the factories are lighted throughout by electricity, and are equipped with improved machinery.

Russian Field Guns

Russia has recently achieved noteworthy success in the manufacture of

principally of the famous Cossacks, has long been the pride of the Empire and one of the most formidable and picturesque military organizations in the world. Riding backward or forward, sitting in the saddle or standing, the cavalryman with his horse going at full speed wields his rifle with a skill that has amazed all nations. The Journal of the United States Cavalry Association says:



COMPARATIVE STATISTICS OF JAPANESE AND RUSSIAN EMPIRES.

"There is only a comparatively small cavalry force available for the Japanese army—about 10,000 out of 300,000, or about 3 per cent. The Japanese are not a nation of horsemen, and are badly supplied with stock."

The Japanese cavalry are armed with the carbine and saber. Only the officers and noncommissioned officers carry revolvers. The horses are small, being little more than ponies, and the weight they carry is much more than in the American service. Japanese officers and cavalry riders carry sabers which may be swung lightly with one arm. The blade of these sabers is of Japanese workmanship, wrought with a skill handed down from the olden time, and is said to equal in temper even that of the famous Damascus steel.

Pontoon Bridges

In handling artillery, cavalry, and infantry; constructing bridges, moving supplies, stringing telegraph wires, building roads, and constructing breastworks; in fact, in nearly every operation of war, mechanics plays a most conspicuous part in this day. Indeed, war might now be called the great contest of mechanical skill.

Engineers whose business it is to understand bridge-building compose a most important constituent of an army in the field. Until the beginning of the land operations of the Far-Eastern war, there was probably no bridge known to us that was not known to the Greek, Roman, and Persian soldiers in their great campaigns. Constructing bridges by civilians is the work of weeks and months; in military bridging, it is the work of minutes and seconds. The bridge most generally used in war is constructed of pontoons. The pontoon is a flat-bottomed boat. A num-

ber of these are fastened together by balks laid on beams placed longitudinally in the center of the anchored boats, on which, transversely, are laid the planks that make the roadway of the bridge.

In the Russian army there are eight pontoon battalions. A stream of 40 or 50 feet in width can easily be bridged in about ten or fifteen minutes, including the clearing of the immediate approaches. The pontoons are sufficiently buoyant to allow of the passage of field artillery or cavalry as well as infantry; and, with a little extra time and care, bridges of this description can be made to carry siege guns and even steam sappers. It is an interesting sight to see a pontoon battalion at work. In a few minutes the flat-bottomed boats are emptied of the bridging tackle, which is stowed away inside. Steadying ropes are adjusted from the banks, and, after a few moments of apparent confusion, the men get their craft dressed in line while the deck hands are making, and lashing fast to, the roadway of planks.

SIXTH PONTOON BATTALION OF RUSSIAN ENGINEERS ON WAY TO THE FRONT.

Cask and Trestle Bridges

Another form of floating bridge extensively used is known as the "cask" bridge. Ordinary beer or water casks are lashed in such a way as to form a substitute for pontoons. A third form of bridge is the "trestle" bridge; but this can be used only when the ravine or river is narrow.

Soldiers often cross rivers by ferry. In these cases, boats, or rafts made of boats, barrels, etc., are used to convey the troops across the streams. These punts, or rafts, may be either rowed or poled, or may be hauled across by means of a rope reaching from bank to bank—this last-mentioned method being available only in case of a narrow stream, one not more than fifty or sixty yards wide, and then only when the current is not strong; or, again, they may be hauled across by using a hawser passed over the raft on rollers, or through hawse holes made for the purpose in its sides or ends. If a wire rope be stretched from bank to bank, so as to be at its lowest point at least three or four feet above the highest flood level, the ferryboat or raft may be fastened to it by a short line secured to a large ring working loose on the wire rope, or to specially constructed running gear provided with pulleys. The boat or raft can then easily be hauled backwards and for-

wards by means of a line secured to each bank of the river, no matter how swift the current may be.

Flying Bridges

One of the most exciting methods of crossing a river is by means of what is known as a "flying" bridge. The principle of this bridge the same as that of a kite. In this case the boat or raft is attached by hawser to a stationary boat in such a way as to be kept at an oblique angle to the stream, and the current is made use of to drive the flying boat across. In making a pontoon bridge it is important to select a site as near as possible to an existing road, as the connection of the bridge with the nearest hard road is often as difficult a piece of work as the construction of the bridge itself.

horses and coolies do the work. The rice is done up in 60-pound sacks. One coolie can carry a sack all day over the most rugged country. Meat is put up in half-pound tins, 80 of which tins are encased in a box. One horse, under three of these boxes, carries one meat ration for a company. Four horses carry a meat ration for a battalion. A sheet-iron cylinder, carried in sections, constitutes a camp stove. This stove is 27 inches high and 30 inches in diameter. In this the fire is built, and into it is fitted a sheet-iron kettle. Into this, in turn, is fitted a perforated kettle, in which the rice is cooked. One kettle will cook rice for 100 men. Eight or nine kettles suffice for a battalion. Sodium sulphate in tins, for precipitating the impurities of drinking water, is part of the outfit.

RUSSIAN INFANTRY ON THE MARCH.

Commissariat Service

In the matter of handling supplies to facilitate the expeditious movement of troops, Japan, with probably the most perfect system in the world, has a great advantage over Russia. All supplies of the Mikado's army are done up in packages, covered with matting, of a size that can easily be carried by one man. This prevents waste, and reduces the difficulty of transit to a minimum. There are no army wagons or army mules. Pack

The Soldier's Kit

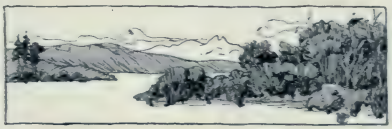
In small cotton bags, weighing little and occupying small space, are carried "emergency" rations. This ration is made of rice, boiled, and then dried in the sun till each grain has shrunk to the size of a pin head. Each soldier carries six of these rations in his knapsack. On a pinch they would suffice him for days. Rice is to the Japanese what bread and butter and meat are to the American.

The Japanese soldier's kit is light and

complete. Including 120 rounds of ammunition, it weighs 42½ pounds. The kit of the American soldier weighs 55 pounds. The soldier's mess pan is of aluminum, blackened on the outside. It will hold two rice rations, which, cooked in the morning, he may carry with him for the day. The water bottle is also made of aluminum, and, when filled, holds a full pint.

Thus it is seen that in this present war, in a day when the value of new inventions and devices is appreciated more than at any preceding time, many skillful conceptions have made their appearance. When the war is over, an inventory of stock of the armament of nations will doubtless reveal many millions of dollars worth of weapons and other mechanisms that have been rendered useless by later and more effective machines. Hundreds of millions of dollars of additional expenditure will then be required to equip the armies and navies of the world in accordance with the new standards that will have been set.

JAPANESE BATTERY OF FIELD GUNS ON THE MARCH.



Auxiliaries of Engine and Boiler Rooms on Shipboard

No. II.—A Description of Evaporators, Ash Ejectors, and Other Indispensable Secondary Equipments

By FREDERICK D. HERBERT

Editor, *Marine Engineering*

THERE is always a certain amount of fresh water that must be added to the feed to make up for the various losses of steam which are bound to occur. On bodies of fresh water, of course, this "make-up" feed can be procured from overboard; or the entire feed water, if necessary, can be obtained from this source. In steamers running along the coast or engaged in over-sea traffic, this extra amount of feed must either be carried in tanks on board, or distilled from salt water in what is termed an "evaporator." If no evaporator is carried, and the supply of fresh water is exhausted, the make-up feed must be salt water, and this admitted into the system through a cock in the condenser. The last method of using salt water is injurious.

Evaporators

The evaporator is composed of several coils of steam pipe placed inside a closed chamber, with large pipe connection at top to the condenser or second receiver. The chamber is nearly filled with salt water. Steam is led to the coils (which should all be submerged in salt water) from the boiler or from the first receiver. The heat of the steam is transmitted through the salt water raising its temperature until finally the boiling point is reached, when the vapor passes over into the main steam system, as above mentioned. The condensed water in the coils is drawn off to the hot well.

This auxiliary is one which can be run economically if properly understood, but is often a frequent source of trouble and loss of efficiency. As the water is evaporated, the density of the solution increases, owing to the great percentage of salt present. This density must be kept down, so that none of the salt will deposit in the bottom of the chamber on the tubes. This is accomplished by blowing the salt water out, and filling up with a new supply from overboard. A separate pump is generally installed for this purpose. The steam pressure in the coils must not be too high, else the violent

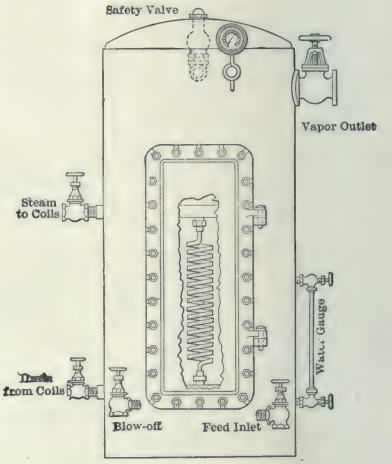


FIG. 1. EVAPORATOR, SHOWING CONNECTIONS AND ONE OF THE COILS.

ebullition will occur which will carry water and salt over with the vapor. The evaporator is fitted with proper gauges and a salinometer, which will advise the engineer of the exact conditions within; and he should be very careful to see that these conditions remain constant, in order to insure economical running.

Ash Removal.—Hoisting Engines

It is outside the province of this article to describe how the coal is put on board

ship, for that is always attended to by shore gangs. One of the most laborious routine tasks on board is that of removing ashes, which, generally speaking, amount to about ten per cent in weight of the coal. Each boiler-room watch has to clean a certain number of fires, and clear out the ashes. The old method—and one which is still very generally followed—is by means of a small hoisting

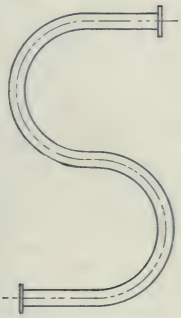


Fig. 2. S-Shaped Copper Bent-Pipe Expansion Joint.

engine, with cable attached leading down through ventilator to the boiler-room floor. The ash-cans are filled up, hooked onto the cable, raised up the ventilator to a deck above the water line, there taken out through a door in the ventilator, carried across the deck, and emptied overboard.

Another system, in place of using the hoisting engine, is to fit a vertical steam cylinder with a pair of triple or quadruple blocks, and have the cable pass over one of the blocks which is stationary and over the other block which is attached to the steam piston. Then, if the piston fitted with a triple block is moved one foot, the end of the cable will travel 3 feet; if the piston has a quadruple block, the cable will travel 4 feet.

The hoisting engine is a very noisy machine, to say the least, and will generally wake up all passengers at night or day who happen to be asleep in its neighborhood. The quiet-running steam ram has many advantages over it. Another apparatus for raising the ashes is a long pipe with plunger fitted with rubber washers, to which the cable is attached directly, the lower end of the cylinder being connected through a valve with the condenser. In this the plunger travels the full height of the lift.

Ash Ejectors

The ash ejector has met with much opposition in several steamship lines, but it quite generally used where the lift is not too great. The usual form consists of a cast-iron box or hopper, into which a nozzle is led directly across the bottom of the hopper. Opposite the nozzle is a large discharge pipe, which leads overboard at a point several feet above the water line. To the nozzle is connected the steam pump, and water under high pressure is delivered to the nozzle. This water, escaping, passes up the discharge pipe. Now, after the pump has been started, ashes may be shoveled into this hopper, and they will be taken up and carried by the water and washed overboard. Should the discharge pipe ever become clogged up by a clinker, the boiler room, of course, will be flooded by the pump. All bends in the discharge pipe should be avoided if possible. The bend near the side of the ship should be

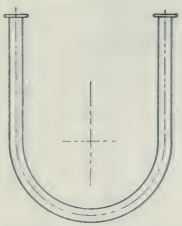


Fig. 2A. U-Shaped Copper Bent-Pipe Expansion Joint.

made removable and extra heavy, as it is found that the ashes will wear it away.

Still another apparatus for removing ashes is found on several ships of the Great Lakes, and consists of an endless belt leading from a hopper in the boiler room to a discharge chute on the upper deck, whence the ashes fall overboard by gravity.

Centrifugal Blowers for Forced Draft

Wherever forced or induced draft for ventilating purposes or for use under boilers is installed, the centrifugal blower is generally used. This consists of a paddle wheel placed in a casing and

driven at high speed. Air enters around the hub, and, passing to the tips of the blades, acquires centrifugal force because of the high peripheral speed, and is discharged in a delivery pipe at the greatest diameter of casing. The fans are designed to handle a large volume of air at low pressure, which is seldom more than equivalent to the pressure of four inches of water, and is generally equivalent to a pressure of about 1½ inches. The fans are driven either by high-speed

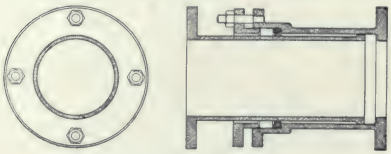


Fig. 3. Expansion or Slip Joint.

engines or—preferably but not generally—by electric motors. One of the greatest sources of trouble with steam-driven fans handling heated air, when placed over the boilers, is in keeping the shafting, fan, and engine (which are some distance apart) in line. In these cases the shafting should be lined up when the fan and engine are hot.

Where fans are to be driven continuously, it is well to fit two engines, one on each end of the shaft, so arranged that either engine may be connectable to the fan. Then, should an accident happen to one engine, that engine may be disconnected and the other one connected without much delay. These engines need a great deal of attention, for, as they run at high speed, many of the more poorly built ones will shake to pieces if not watched.

Bilge Pumps

In case of damage to the hull, or for the purpose of handling the water ballast, one or more large bilge pumps are always installed in the engine room. Pipes connecting each compartment of the ship are laid to a manifold box in the engine room, and from them a pipe leads to the pump. If water from any one of the compartments is to be discharged, that valve in the manifold is opened and the pump started. It is usual to connect up the centrifugal pump with the bilge for use in case of emergency. It is usual also to fit a plunger bilge pump to the air-pump crosshead where a direct-connected air pump is used.

Expansion Joints

Wherever there are long lengths of piping, and wherever there is steam piping laid, ample provision must be made for the contraction and expansion of the pipe due to heating and cooling. In some lines, loops or bends in the pipe, similar in form to the letters S or U, are sufficient to take up this expansion. This, however, is not suitable for piping of large diameter. In such cases a special expansion joint must be fitted. The simplest form consists of two joining pieces (Fig. 3), one cast with one end of greater diameter so as to contain the other piece of pipe, the space between the two being fitted with a stuffing box and packing. This form is not what is termed a "balanced" joint; that is, there is a pressure exerted by the steam, tending to drive the two pieces apart. The joint illustrated in Fig. 4 is self-balanced.

Steam for all the auxiliary machinery except the main feed pump, is generally supplied through an auxiliary steam line, and at lower pressure than that carried in the boiler.

Separators

To remove the condensed steam from the pipes, a "separator" is generally installed. The simplest form consists of

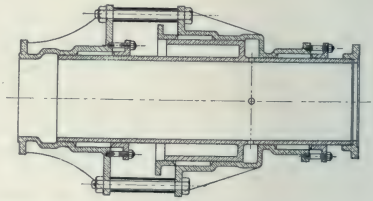


Fig. 4. Steam-Balanced Expansion Joint.

a series of beveled plates placed in the upper part of a receiver, and across the line of flow of the steam. The water in the steam is supposed to be caught on these plates and drawn into the lower chamber, while the dry steam passes through.

For a similar reason a separator is

generally fitted inside the boiler, and consists of a long, perforated pipe suspended at the highest point of the steam space. This is called a "dry pipe." Steam enters it through the perforations, and is carried to the stop valve.

There are a great many other auxiliaries in the engine room of a big ship. In fact, on some of the ocean liners, the number of steam cylinders all told amounts to over two hundred. It is now usual to install an electric lighting plant on all steam vessels except the very smallest. Most of the steamships have refrigerating plants for cooling that part of the cargo space used for carrying perishable freight and stores, and also for making ice for the ship's use. Special engineers are carried to look after these two plants.

On small boats the auxiliaries that give the greatest trouble are the pumps. The points to be looked out for are, briefly: First, that the valves do not become worn out or jambed so that they will not close; second, that the packing rings on the water piston or plunger do not leak, else the water will simply be churned from one end of the cylinder to the other and will not pass out through the delivery.

On the steam end, the usual points to be observed are similar to those in the case of any steam engine; but especially should the valve be looked after, to see that it does not get out of adjustment through wear or other causes.

Several small pumps besides those mentioned are usually to be found on small vessels—such as a fresh-water pump for handling the drinking water, a sanitary pump for delivering salt water where needed, and sometimes a small pump for circulating the water through the bearings of the main engine.

Types of German and English Locomotives

Measurements and Constructive Details of Several Recently Built European Engines

By FRANK C. PERKINS

Passenger Engines

SOME INTERESTING TYPES of high-speed passenger locomotives have recently been constructed for the Prussian State Railways, and the *Madrid-Zaragoza-Alicante* Railway Company at the Locomotive Works at Linden, near Hanover; also for the *Kgl. Bayer Staatseisenbahnen* at the Locomotive Works at München, Bavaria; and for the Lancashire & Yorkshire Railway at the Harwich Locomotive Works in Lancashire, England.

Fig. 1 shows an English 10-wheeled bogie passenger engine and tender recently designed by Mr. H. A. Hoy, chief mechanical engineer of the Lancashire & Yorkshire Railway; while Fig. 2 shows a similar type of German express locomotive with four coupled driving wheels, a four-wheeled bogie in front and two trailing wheels back of the drivers. This engine, however, is of a compound type built by the *Hannoversche Maschinenbau-Actien-Gesellschaft*, formerly Georg Egestorff, of Linden, near Hanover, Germany. The two front axles run in the bearings of a turntable swinging on a fixed cylindrical pivot, thus admitting of lateral as well as radial motion.

The two high-pressure cylinders are inside, and measure 360 mm. (14.1732 in.) in diameter, while the two low-pressure cylinders are outside the frames, and measure 560 mm. (1.8372 ft.) in diameter. All four pistons work on the same axle, and the driving wheels are 1,980 mm. (6.496 ft.) in diameter, while the

leading wheels are 1,000 mm. (1.0936 yds.) in diameter. The frames are inside the wheels; the gauge measures 1,435 mm. (1.5693 yds.). The stroke of a wheel base of 4.5 meters (4.9212 yds.). The tanks have a capacity for 19,000 kilograms (20.94 tons) of water, and the coal bunkers have a fuel space for 5,000

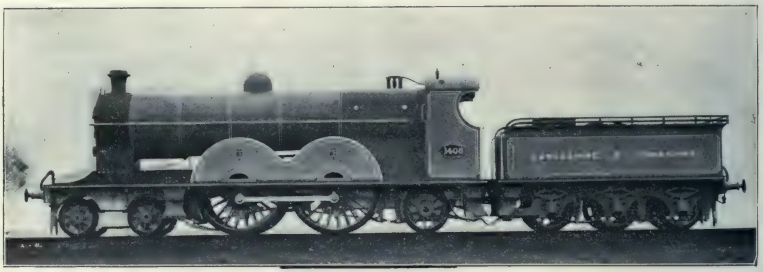


FIG. 1. ENGLISH TEN-WHEELED BOGIE PASSENGER ENGINE AND TENDER.
Built for the Lancashire & Yorkshire Railway.

the pistons is 600 mm. (1.9685 ft.) in length, and a simplified Heusinger gear of Borries pattern is employed. This passenger engine has a rigid wheel base of 2,100 mm. (2.2966 yds.), and a total wheel base of 9 meters (9.8424 yds.).

The boiler pressure used is 14 atmospheres, and the total heating surface of the boiler is 162 square meters (193.752 sq. yds.), while the grate area of the kilograms (5.51 tons). The tender, supplied with water and fuel, weighs 45,200 kilograms (49.82 tons). The total length of this German compound passenger engine and tender combined is 18,055 mm. (19.74+ yds.).

The four-cylinder compound high-speed locomotive shown in Fig. 3 and the compound high-speed engine noted in Fig. 4, were constructed for the *Kgl. Bayer*

FIG. 2. GERMAN COMPOUND EXPRESS LOCOMOTIVE.
Built for the Russian State Railways.

fire box is 2.7 square meters (3.2292 sq. yds.). The engine weighs empty 54,200 kilograms (59.74 tons); and when supplied with fuel and water and in working order, it weighs 60,200 kilograms (66.35+ tons), the adhesive weight being 31,300 kilograms (34.5 tons).

The tender has four axles with wheels 1,000 mm. (1.0936 yds.) in diameter and

Staatseisenbahnen, by the *J. A. Maffei Maschinenfabrik* of München. The compound engine of Fig. 3 is of the four-wheeled coupled type, with a four-wheeled bogie in front and a two-wheeled trailing axle back of the drivers; while that seen in Fig. 4 is of the six-wheel coupled type, with a four-wheeled bogie in front. The former operates at a steam

pressure of 16 atmospheres, and the latter at a pressure of 14 atmospheres. The engine shown in Fig. 3 has a high-pressure cylinder 340 mm. (1.115 ft.) in diameter, and a low-pressure cylinder 570 mm. (1.87 ft.) in diameter, with a stroke of 640 mm. (2.09 ft.). It was designed for a minimum curve radius of 180 meters (196.848 yds.), and for a maximum grade of 10 per cent. The

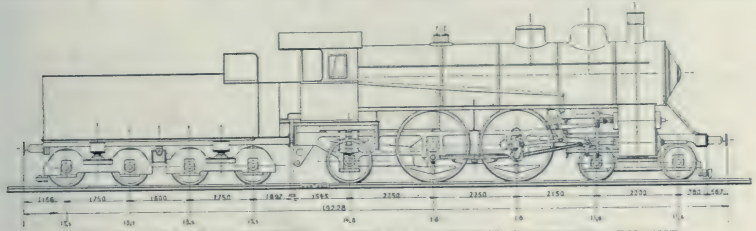


FIG. 3. GERMAN FOUR-WHEEL COUPLED COMPOUND PASSENGER ENGINE.
Built for the Kgl. Bayer Staatseisenbahnen by the J. A. Maffei Maschinenfabrik of München, Bavaria.

four driving wheels each have a diameter of 2,000 mm. (2.1872 yds.), and the draw-bar pull is 5,300 kilograms (5.842 tons). The boiler has a total heating surface of 205.5 square meters (245.778 sq. yds.), of which 191 square meters (228.436 sq. yds.) represents the heating surface of the 283 tubes provided in this engine, and 14.5 square meters (17,342 sq. yds.) represents the heating surface of the fire-box, which has a grate area of 3.28 square meters (3.9228 sq. yds.). This engine has a weight of 123,000 lbs. (23.148 tons). The total length of wheel base of this locomotive and tender combined measures 16.72 meters (18.2849 yds.), and the gauge for which it was constructed is 1.435 mm. (1.56 yds.).

The six-coupled four-cylinder compound high-speed locomotive shown in Fig. 4 has the same wheel base for the locomotive and tender, and weighs practically the same when empty and when in working order. It was designed for the same gauge, minimum curve radius, and maximum gradient, but is a trifle longer over all.

The high-pressure cylinder measures 335 mm. (1.09+ ft.) in diameter, and the low-pressure cylinder 570 mm. (1.87 ft.) in diameter, with a stroke of 640 mm. (2.09 ft.). The driving wheels of this engine are not so large, measuring 1,870 mm. (6.13 ft.) in diameter; but the draw-bar pull is greater, being 6,000 kilograms (6.61 tons). The boiler has a greater

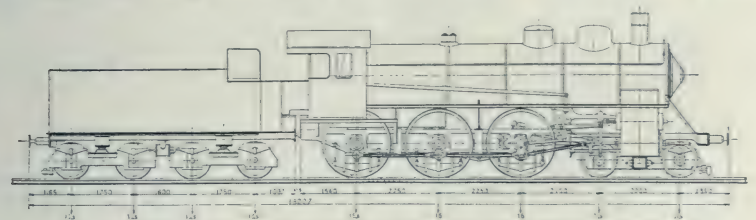


FIG. 4. GERMAN SIX-WHEEL COUPLED COMPOUND HIGH-SPEED LOCOMOTIVE.
Built for the Kgl. Bayer Staatseisenbahnen.

empty, and when loaded with fuel and water weighs 68.5 tons. The tender is 3.12 meters (3.412 yds.) wide and 7.45 meters (8.1473 yds.) in length, with a total wheel base of 5.1 meters (5.5773 yds.). It has a fuel capacity for 7,000 kilograms (7.716 tons) of coal, and a water capacity of 21,000 kilograms

heating surface, but the same number of tubes. The heating surface of the 283 tubes is 196 square meters (234.416 sq. yds.), while that of the fire-box is 14 square meters (16.744 sq. yds.), the latter having a grate area of 3.28 square meters (3.9228 sq. yds.). The total heating surface of the boiler is, therefore, 210

square meters (251.16 sq. yds.), and steam is supplied at a pressure of 14 atmospheres.

The German six-coupled compound passenger locomotive of Fig. 5 was built for the *Madrid-Zaragoza-Alicante* Railway Company by the *Hannoversche Maschinenbau-Actien-Gesellschaft,* formerly Georg Egestorff, of Linden. This engine has five axles, the two front ones running in bearings of a turntable swinging on a fixed cylindrical pivot, thus admitting of a lateral as well as a radial motion. The two high-pressure cylinders outside the frames are 350 mm. (1.148+ ft.) in diameter, and drive the second driving axle. The two low-pressure cylinders inside the frame are 550 mm. (1.8 ft.) in diameter, with a stroke of 650 mm. (2.13 ft.), and drive the first driving axle. The frames are inside the wheels, the gauge being 1,672 mm. (5.48 ft.). The driving wheels are 1,750 mm. (1.9 yds.) in diameter, and the leading wheels 850 mm. (2.53 ft.) in diameter. The total wheel base of this engine measures 7,600 mm. (8.3 yds.); and the rigid wheel base 4,000 mm. (4.37 yds.).

The boiler pressure used is 14 atmospheres, and the boiler has a total heating surface of 182 square meters (217.67 sq. yds.), the grate area being 27 square meters (37.29+ sq. yds.). The length of the frame is 9,900 mm. (10.8 yds.); and the total weight of the engine in working order, with fuel and water, is 58,000 kilograms (63.93 tons), while the weight of the engine empty is 52,000 kilograms (57.31 tons), the adhesive weight being 40,600 kilograms (44.75 tons).

The tender provided for this locomotive has 3 axles, with a wheel base of 3,350 mm. (3.66 yds.), the wheels measuring 1,150 mm. (1.25 yds.) in diameter. The length of the frame of the tender is 5,840 mm. (5.55 yds.); and it has a capacity for 4,000 kilograms (4.409 tons) of fuel, and a tank capacity of 14 cubic meters (18.312 cub. yds.) of water. The tender weighs empty 17,000 kilograms (18.7 tons); and, when provided with fuel and water, the weight is 35,500 kilograms (39.13 tons). The engine and tender combined have a total length of 17.03 meters (18.6 yds.).

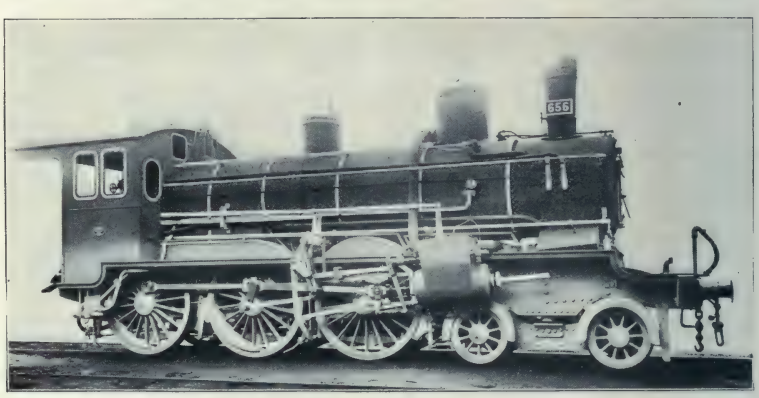


FIG. 5. GERMAN SIX-COUPLED COMPOUND PASSENGER LOCOMOTIVE.
Built for the Madrid-Zaragoza-Alicante Railway.

Tank Engines

It may be of interest to note some of the details of construction of recent tank engines constructed in England for the London & Northwestern Railway and the Lancashire & Yorkshire Railway, as well as the German tank engines built at Esslingen and München.

Fig. 6 shows an English radial tank engine built at the Harwich Locomotive Works. This four-wheeled coupled locomotive was designed for the Lancashire & Yorkshire Railway by Mr. H. A. Hoy, chief mechanical engineer of this system. The six-wheeled coupled side-

tank passenger engine shown in Fig. 7 was constructed for the working passenger traffic over the heavy gradients on the

FIG. 6. ENGLISH TANK ENGINE.
Built at Harwich Locomotive Works, from Design of H. A. Hoy.

Buxton and High Peak Branch of the London & Northwestern. A number of these engines, designed by Mr. F. W. Webb, chief mechanical engineer of the system, are engaged in working the heavy suburban passenger traffic at different points.

The cylinders are 18 inches in diameter and have a 24-inch stroke. The valves, which are of the piston type, are worked with Joy's gear. The driving and coupled wheels are 5 feet 2½ inches in diameter, with 3-inch tires, and the axle bearings are 7 inches in diameter and 9 inches long. In addition to these, the driving axle has a central bearing midway between the two cranks 7 inches in diameter by 5½ inches long. The trailing end of the engine is carried by a pair of wheels 45 inches in diameter, the axle being fitted with Webb's radial axle box, the bearing being 6¼ inches in diameter by 12 inches long.

The total heating surface of the boiler is 1,083.5 sq. ft.; and the grate area, 17.1 sq. ft. The tanks have a water capacity

FIG. 7. ENGLISH SIX-COUPLED SIDE-TANK PASSENGER ENGINE.
Built for the London & Northwestern Railway.

of 1,420 gallons, and the coal bunkers will carry 3 tons of fuel.

The total weight of the engine in working order is 52 tons 6 cwt., of which 41 tons 16 cwt. is carried by the coupled wheels. The total wheel base of this engine is 22 feet 3 inches. The distance

from the leading to the driving wheels is 7 feet 3 inches; from the driving to the trailing coupled, 8 feet 3 inches; and from the trailing coupled to the radial wheels, 6 feet 9 inches. This locomotive was constructed at the Crewe Works.

Figs. 8 and 9 give the general wheel-base dimensions and total length, as well as the general idea of the German con-

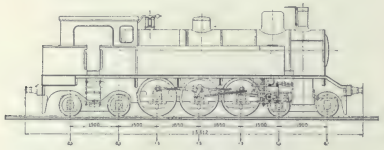


Fig. 8. High-Speed German Tank Engine. Built for the Madrid-Zaragoza-Alicante Railroad by the J. A. Maffei Maschinenfabrik of Munchen, Bavaria.

struction, of a 6-coupled high-speed tender locomotive built for the *Madrid-Zaragoza-Alicante Eisenbahnen,* and a duplex compound tank engine constructed for the *Gotthardt-Bahn* by the *J. A. Maffei Maschinenfabrik* of München. The former as well as the latter operates at a steam pressure of 12 atmospheres. The six-coupled high-speed tank engine has a cylinder 440 mm. (1.4 ft.) in diameter and a stroke of 630 mm. (2.07 ft.). The six driving wheels have each a diameter of 1,544 mm. (5 ft.); and the draw-bar pull of this engine is 4,725 kilograms (5.1 tons). The boiler has a total heating surface of 172 square meters (205.7 sq. yds.), and a grate area of 2.85 square meters (3.408 sq. yds.).

This locomotive has a total wheel base of 10,100 mm. (11 yds.), and was designed for a minimum curve radius of 180 meters (196.84 yds.). The locomotive, complete in working order, weighs 71.5 tons, and when empty, 54.5 tons. The tank capacity is for 8,000 kilograms (8.8 tons) of water, while the fuel bunkers will carry 3,500 kilograms (3.8 tons) of coal. This locomotive was designed for a gauge of 1,672 mm. (5.4 ft.) and has a total length of 13,312 mm. (14.5 yds.). It has a total width of 3.1 meters (3.3 yds.), and a total height of 4.3 meters (4.7 yds.).

The compound tank engine of Fig. 9 was designed for a minimum curve radius of 180 meters (196+ yds.) and for a maximum grade of 27 per cent, the total wheel base being 8.13 meters (8.89 yds.). The high-pressure cylinder has a diameter of 400 mm. (1.3 ft.), and the low-pressure cylinder measures 580 mm. (1.9 ft.) in diameter, while the stroke is 640 mm. (2.09 ft.). This engine has 12 driving wheels, each 1,230 mm. (4 ft.) in diameter, and has a draw-bar pull of 9,000 kilograms (9.92 tons). It was designed for a gauge of 1,435 mm. (1.56 yds.), and has a water-tank capacity of 7,060 kilograms (7.78 tons), and a fuel capacity of 4,800 kilograms (5.29 tons). This engine weighs 68 tons empty, and 85 tons when in working

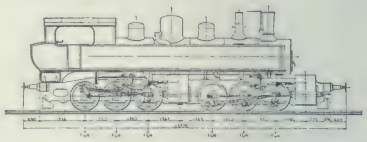


Fig. 9. German Duplex Compound Tank Engine. Built for the Gotthardt Railroad.

order, with supply of fuel and water. The boiler has a total heating surface of 154 square meters (184.184 sq. yds.). It is supplied with 190 tubes, having a total heating surface of 145 square meters, (173.42 sq. yds.), and a fire-box with a grate area of 2.3 square meters (2.63 sq. yds.), and a heating surface of 9.3 square meters (11.12 sq. yds.).

Great Technical Schools

Lawrence Scientific School, Harvard University, Cambridge, Massachusetts

By CARL S. DOW, S. B. (Harvard, '97)

UNTIL 1847, the year in which instruction in Engineering at Harvard University commenced, nothing had been done in New England in the way of special education for engineers or mechanics. At this time several prominent men at Harvard felt the need of instruction of an advanced character in the professions depending upon exact science. The governing boards of Harvard University outlined a plan for an advanced school of science and literature, the establishment of which was made possible by the generous gift of the Hon. Abbott Lawrence.

In a letter to the treasurer of Harvard College, Mr. Lawrence said in part:

"For several years I have seen and felt the pressing want in our community—and, in fact, in our whole country—of an increased number of men educated in the practical sciences. Elementary education seems to be well provided for in Massachusetts; but where can we send those who intend to devote themselves to the practical application of science? How educate our engineers, or miners, machinists and mechanics? Our country abounds in manufactures; hard hands are ready to work upon our hard materials; but where shall sagacious heads be taught to direct those hands?

"We need, then, a school, not for boys, but for young men whose early education is completed either in college or elsewhere, and who intend to enter upon an active life as engineers or chemists, or, in general, as men of science, applying their attainments to practical purposes. I therefore propose to offer through you, for the acceptance of the President and Fellows of Harvard College, the sum of $50,000, to be appropriated as I have indicated in the foregoing remarks."

Of this gift, about $30,000 was expended in the erection of a building, Lawrence Hall; and the remaining $20,000 was kept to sustain the professorships of Engineering and Geology. Mr. Lawrence continued to show his interest in the School, both by wise counsel and by financial aid. At his death he bequeathed to it a second $50,000.

In 1847, instruction in Chemistry was given by Professor Horsford; and in the same year, Louis Agassiz was chosen Professor of Geology and Zoölogy, but did not begin teaching until the following year. At this period the only requirement for admission was a common English education, the examination being an oral inquiry by the Professor.

LAWRENCE HALL, HARVARD UNIVERSITY.
Built in 1848.

When President Eliot was inaugurated in 1869, plans were actively discussed for the entire reorganization of the Lawrence Scientific School. A thorough four years' course was provided in Civil and Topographical Engineering. This work was placed in the hands of Charles Frederick Hoffman, who remained at Harvard but one year. The candidates for admission, except college graduates, were now required to

pass examinations in Arithmetic, Algebra, Geometry, and Trigonometry. In most cases, graduates of colleges entered in advanced standing.

It seems that the principal aim in establishing this Scientific School was to

THE YARD.

give instruction to graduates; thus the Lawrence Scientific School was, in its purpose, the beginning of a graduate school, and was the first graduate school established by any college in America. Here many experiments were tried which formed the basis of graduate instruction and of the Graduate School of Harvard University.

Among the well-known men who have conducted instruction and research at the Lawrence Scientific School, may be mentioned Benjamin Pierce, in Advanced

SEVER HALL.

Mathematics; Asa Gray, in Botany; Professor Horsford and Josiah P. Cook, in Chemistry and Mineralogy. In the Lawrence Scientific School, Louis Agassiz introduced the "laboratory" method of teaching science. President Eliot, referring to the work of Professor Agassiz, said:

"When he was appointed Professor, there was no laboratory for students' use in the entire University, excepting the dissecting room for human anatomy, in the Medical School. The numerous well-appointed laboratories of today, not only in Harvard University, but in all the institutions of higher learning and even in well-equipped secondary schools, bear witness to the importance of this reform in which Agassiz was the pioneer. He aroused new intellectual interests all over the country, raised the popular conception of the name of science,

BOYLSTON HALL.
Chemical Laboratory.

introduced on a great scale improved methods of teaching the science dear to him, and gave a new meaning to the word 'teacher.'"

Agassiz placed his collections in the second story of the Zoölogical Hall, and in a few years increased them so rapidly that he crowded Professor Eustis out of the building. From these collections has grown Harvard's great Museum of Comparative Zoölogy. This Museum

was founded by Agassiz in 1859, and has cost more than $1,100,000. It possesses an invested endowment of over $600,000.

The Lawrence Scientific School is now and has always been an "educational laboratory," a department in which the University makes many of its educational experiments.

The real growth of the School has been since 1887. At this time several changes took place regarding the equipment, and the relation of the Scientific School to other departments of the University. In 1893, Ira N. Hollis was appointed Professor of Engineering. Professor Hollis was graduated from the United States Naval Academy, and served in various positions in the Navy for fifteen years. When he resigned, he was on duty in the Bureau of Steam Engineering as assistant to the Engineer-in-Chief. Under his able management the Engineering Department at Lawrence Scientific School has grown rapidly, and many new courses have been added.

In March, 1896, the three Departments—Harvard College, the Lawrence Scientific School, and the Graduate School—became united under one governing board, called the Faculty of Arts and Sciences. This proceeding placed the student in the Lawrence Scientific School on exactly the same footing as a student of Harvard College.

For many years the instruction was not appreciated by most people. One of the chief reasons for this was that the requirements for admission were not of the high standing of those for the College. The requirements, however, have been gradually raised, until now the Scientific School uses exactly the same examinations as Harvard College. The examinations are identical, and are governed by the same rules and by the same officers. Any subject for admission to Harvard College can be counted by the candidate for admission to the Scientific School. In addition, ten subjects on Science and shop work are accepted for admission to the Scientific School, but not to the College.

The two most noteworthy recent events have been the erection of Pierce

JOHNSTON GATE.

PIERCE HALL.

Hall, and the acquisition of a large tract of land in New Hampshire for the Harvard Engineering Camp.

Pierce Hall

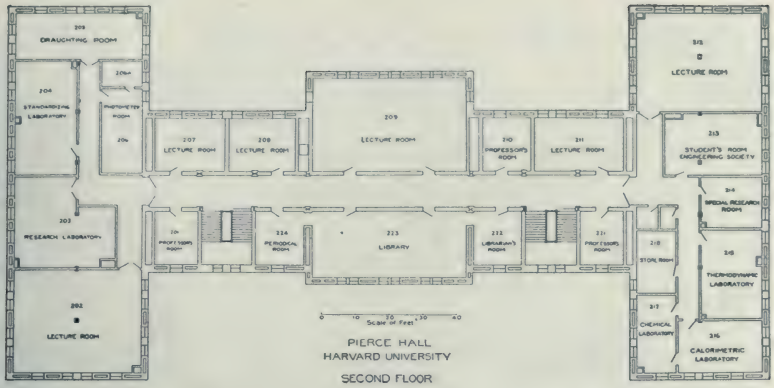
Until 1901, the instruction in Engineering was given at Lawrence, Massachusetts, and in Sever Hall and the Old Gymnasium. During the few years following the appointment of Professor Hollis, the increase in the number of students was so rapid that the accommodations soon became inadequate—especially the laboratories and drafting rooms.

MATERIAL-TESTING LABORATORY.

In 1899, the Corporation of Harvard University appropriated $175,000 for a new building for the Engineering Department. This building—called Pierce Hall, after Henry L. Pierce, from whose great bequest the money was taken—was ready for use during the college year 1901-02. Its equipment, however, is not yet complete, as it is the policy of the department to purchase machinery only as it can be profitably used, thus avoiding an accumulation of machinery that soon becomes out of date.

In Pierce Hall all the work in Civil, Mechanical, and Electrical Engineering is carried on, also the Mathematics for the Scientific School. The building is conveniently located on Holmes Field, near the Agassiz Museum and the Jefferson Physical Laboratory. Instruction in Chemistry is given in Boylston Hall.

On entering Pierce Hall it becomes apparent that the main idea has been to construct a useful building, one conveniently arranged but without expensive finish. The accompanying plan shows that the maximum amount of light and air is given to each room. There are two large wings and a central portion containing lecture rooms, laboratories, drafting rooms, and offices. The building covers 17,200 square feet of ground; and there are, exclusive of halls, stairs, etc., 63,196 square feet of space in the four floors. On the top floor are located the drafting rooms for designing, descriptive geometry, and graphic statics. On the second floor, in the center structure, is a lecture hall for 120 students, and a library having a capacity of 6,000 or



7,000 volumes. In general, the laboratories are in the wings.

The south wing contains the machinery and apparatus for Electrical Engineering, and the testing machines for testing materials of construction. The north wing contains machines for experimental work, such as gas engines, steam engines, and hydraulic machinery. In the Hydraulic Laboratory, there is a large vertical tank for water pressure up to 150 pounds per square inch. The tank is supplied from a cistern by a Blake pump. The water passes to the vertical tank, or into smaller tanks for weir measurements; from the vertical tank it may be discharged into a large cast-iron tank 21 feet long by 6 feet wide by 4 feet deep. The water may next pass from the tank into a canal, and then flow to either of two weighing tanks, each having a capacity of about 700 gallons.

In the Dynamo Laboratory, machines are arranged in pairs, each pair consist-

DYNAMO LABORATORY.

ing of a dynamo and motor connected by a belt. This arrangement avoids all shafting, and affords an easy means of shifting machines. The equipment at present consists of a large number of machines, including generators and motors for direct and alternating currents. In the Transformer Laboratory there are various types, including special experimental transformers, one of 20-K. W. 40,000-volt capacity, for insulation testing.

The boiler room is fitted with pumps and two Babcock & Wilcox boilers. On the same floor is a workshop for making new apparatus, and for experimental investigation of cutting tools and the power required for driving machine tools.

The Power Laboratory contains a 34-horse-power gasoline engine direct-connected to a Crocker-Wheeler generator. This unit is for charging the storage batteries and lighting the building during the summer. In the same room is a compound steam engine for supplying current to the Electrical Laboratory. The building itself is lighted by a 100-K. W. 120-volt Westinghouse generator.

HYDRAULIC LABORATORY.

Harvard Engineering Camp

Under the old system of teaching surveying during the regular terms of the college year, only simple problems could be attempted. To make the work more interesting, and more extended field work possible, first-year and second-year students were required, in 1895, to devote five weeks to summer field practice. The first camp was on Martha's Vineyard island, on land placed at the disposal of the Lawrence Scientific School by Dean Shaler. The scheme was so successful that in the fifth year the period was lengthened to seven weeks. This method enabled students to take surveying during the summer, thus allowing time for extra courses during the college year.

In the spring of 1901, generous friends of the Engineering Department gave the Engineering Camp a permanent home. A commodious camp was built on a large tract of land on the southeastern shore of Squam Lake in New Hampshire. The camp consists of a large living room, a lecture room, instrument room, drafting room, and a dormitory large enough for

STUDENTS IN CIVIL ENGINEERING.

Harvard Engineering Camp, Squam Lake, New Hampshire.

forty students. In addition, there is tenting room for two hundred.

The program of study has changed somewhat from that followed at Martha's Vineyard. Now the period is eleven weeks instead of seven, and no instruction in surveying is given during the college year. Six weeks are devoted to land and topographical surveying; two weeks to geodetic; and three weeks to railroad. Students are organized into parties of four, each party being directed by one of its members. Each member in turn serves as chief, and is responsible for the instruments and the work done. All notes are made in field books, and then copied into the office book. After the surveys are completed, the necessary computations are made and the map plotted.

As the working day ends at four o'clock, and no work is done in the evening (except for a short period), there are opportunities for recreation, such as swimming, canoeing, baseball, etc. Living out of doors during both laboratory periods and recreation time, the student thoroughly enjoys the long vacation even though a considerable portion of it is spent in study.

In addition to the Surveying, Shopwork, and other courses given during the summer vacation, there are several summer courses in Field Geology. A party of students having some knowledge of geology will visit the Black Hills, and the Big Horn Mountain in Wyoming. Another party will visit the Colorado Rocky Mountains, the Grand Canyon of the Colorado in Arizona, and California. Prof. W. M. Davis will accept a few students as fellow-workers in his examination of the Great Basin mountain ranges.

Harvard Engineering Society

This society, formed more than ten years ago, is composed of engineering students, professors, and instructors. Its value to all engineering students can hardly be overestimated. It promotes an interest in engineering by bringing the members together once a month to

hear prominent engineers lecture on technical subjects. To still further stimulate interest in engineering, the society is divided into clubs or sections, called the Mechanical Engineering Club, the Civil Engineering Club, and the Electrical Engineering Club.

UNIVERSITY HALL.

Containing Offices of Administration.

In conjunction with the Department of Architecture, the Society publishes a quarterly magazine called the *Harvard Engineering Journal.* Its object is to preserve the lectures given before the

A Corner of the Yard.

society and to publish articles by graduates.

The Engineering Society owes much to Professor Hollis. He was the organizer, the first president, and the chairman of the committee appointed to choose the editorial board and supervise the publication of the *Journal.* Through his efforts, many well-known engineers have taught Harvard students the value and dignity of the engineering profession.

Instruction in Engineering

At the present time the instruction in engineering at Harvard is, in general, of the same character as that prevailing in the leading technical schools of the United States. Engineering students at the Lawrence Scientific School, however, are benefited by some conditions that exist only at Harvard.

The first of these conditions is found in the instruction itself. At Harvard, the teachers of engineering are in close touch with the able professors of languages, sciences, history, and other subjects; they serve on the same faculty and on the same committees. This is one of the results of placing the College, the Scientific School, and the Graduate School under the same faculty.

The close relation existing among these three departments has an important influence on the requirements for degrees. To obtain the degree of Bachelor of Science in Engineering, a student must be registered in the Scientific

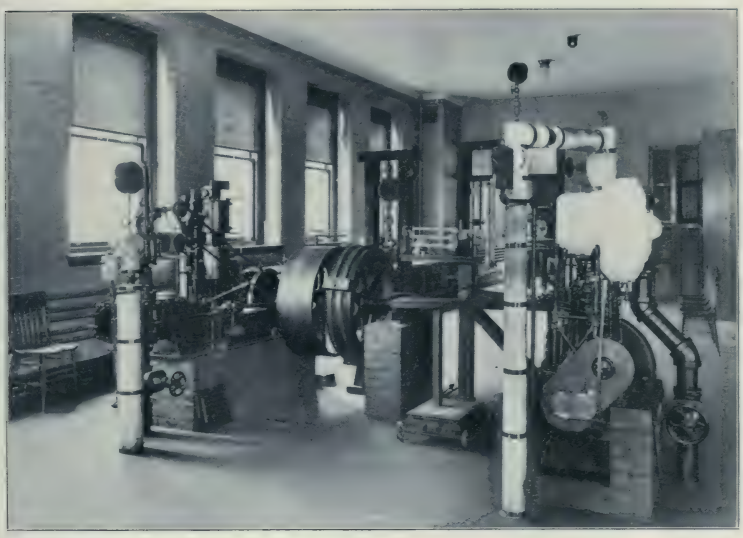
School at least one year. As about three-quarters of the instruction in engineering counts in the College for the degree of Bachelor of Arts, a student in engineering may be registered in the College for two or three years, and then transfer to the Scientific School for his senior year.

One who can devote five years to college work at Harvard may thoroughly prepare for professional success by spending the first three or four years in Harvard College, where, under the elective system, he may choose subjects according to his taste or plans, provided his work follows approximately the program of the Scientific School. At the end of the five years, he receives the degree of A. B., and also that of S. B. in one of the branches of engineering. This is in accordance with the idea of making the work leading to the degree of A. B. as preparatory to the engineering courses, or the placing of engineering instruction under the head of graduate work.

The second feature of instruction in engineering at Harvard is the arrangement of the programs. For the first three years, the instruction in Civil, Mechanical, and Electrical Engineering is practically the same. The candidate for the degree of S. B. in Civil Engineering pursues the same studies as does the student in Electrical Engineering, with the exception of the summer work. The summer work for Mechanical and Electrical Engineering students is Shopwork, while that for Civil Engineering students is Surveying.

Students choosing Civil Engineering are required (and all others recommended) to take the summer courses in Plane, Geodetic, and Railroad Surveying before the beginning of the fourth year. Students choosing Mechanical or Electrical Engineering are required (civil engineers are recommended) to take the summer courses in Shopwork before the beginning of the fourth year.

This arrangement permits the student to postpone the time of making a choice of a specialty until he has had a broad and thorough training in the fundamental principles of engineering. It prepares the graduate to accept an attractive



STEAM ENGINE LABORATORY.
Pierce Hall.

opportunity in any branch of engineering. It does away with the idea that one is obliged to follow the specialty chosen early in his college career before he had thought of the possibilities in the various branches. As the tendency of engineering practice is toward specialization, it is not the duty of schools to go too much into details, but rather to give a larger, broader training, and leave the specialization to later professional work.

JEFFERSON PHYSICAL LABORATORY.

The third and last condition is the college life at Harvard. The students in the Scientific School have the same rights and privileges as those in Harvard College. The undergraduates are on the same footing. Rooms in College dormitories are assigned to students registered in the Scientific School in the same way as to those in the College. Engineering students have the same rights to gymnasiums, dining halls, and athletic and social clubs. In fact, the college life of an Engineering student is identical with that of a College student.

The influence of a great university cannot but make its impression upon the Engineering student — the numerous evening lectures, the engineering clubs, the libraries, the intercourse with students pursuing different lines of study, the athletic events, the college spirit—all tend to make the Engineering student at Harvard cultured, broad-minded, and self-reliant.

Professor Hollis once said:

"A man's success in life depends upon two things—his opportunity, and his ability to grasp the opportunity when it presents itself. We cannot make opportunities for you; these must come from the industrial world; but we can be of material assistance in preparing you for the opportunities."

It is the aim of the teachers in the Lawrence Scientific School to make the first years of the college training a thorough preparation; the last years a period of carefully selected specialization; and at all times to render such assistance as shall make the student a successful engineer. Harvard endeavors to give Engineers a liberal share of her life, traditions, and ideals, and bestow upon Engineering students a breadth of preparation that shall make her influence felt in this as in other professions.

IN THE YARD AT HARVARD.

Shipbuilding on the Great Lakes

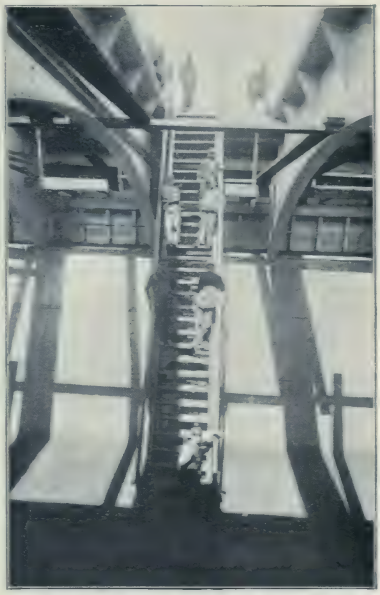
Construction of the Steamer "Augustus B. Wolvin," the Largest Vessel on the Great Lakes and the Largest Exclusive Freighter in the World

By WALDON FAWCETT

THE COMPLETION of the new steel steamer *Augustus B. Wolvin* marks an epoch in the history of shipbuilding on the Great Lakes. Not only is the vessel the largest ever built to navigate fresh water anywhere on the globe, but in many important features of construction she is radically unlike her predecessors designed for similar service. These changes, however, have been induced in greater degree by the necessity for conforming to new conditions at unloading ports, than by the adoption of any new standards in shipbuilding practice generally.

The *Wolvin*, like almost all the other large vessels constructed on the Great Lakes, is destined for freight carrying exclusively; and her especial field of usefulness will be found in the transportation of iron ore from the ports adjacent to the great iron mines in the district bordering on Lake Superior to the unloading harbors on Lake Erie, where the raw material is transferred from vessels to the cars which carry it to the blast furnaces in the manufacturing districts of Ohio and Pennsylvania.

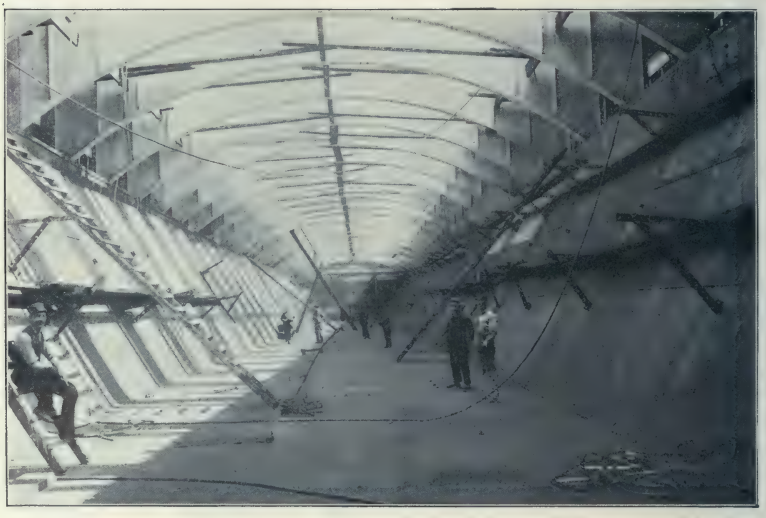
It is in the discharge of bulk cargo at the lower lake ports that there have arisen new conditions which dictated changes in vessel construction as exemplified in the *Wolvin*, the first of a new class of cargo carriers. Formerly the work of taking out the ore was done solely by hand shoveling; but there have recently been invented and introduced machines known as "automatic unloaders," which weigh 400 tons, and the fundamental feature of which is a "clam-shell" grab bucket which, when lowered into the hold of a vessel, automatically scoops up ten tons of ore. In order to permit these mechanical shovelers to gather up all the ore to the best advantage, not only is it necessary to provide a cargo hold of unusual shape, but it is advisable to impart exceptional stability of construction to the whole ship in order that she may withstand the strains imposed in the operation of such heavy unloading machines. These new requirements have been met in the *Wolvin*.



HATCH, SHOWING CONSTRUCTION OF STEAMER "A. B. WOLVIN."

The new steamer has a second element of interest in the fact that she is the largest craft ever floated on the Great Lakes; and here again a new trend of policy is exemplified. When a few years ago a ship approximately 500 feet in length was constructed at a lake shipyard, it was supposed that the limit had been reached—owing, of course, to the

restrictions imposed by the depth of water in harbors and the limitations of the narrow channels connecting the various lakes. Indeed, for a time thereafter, a revulsion of feeling was manifest; and the tendency in shipping circles, when contracts were placed for new vessels, was to return to craft of intermediate size—420 to 450 feet length over all. Therefore the action of the shipping interests affiliated with the United States Steel Corporation, commonly known as the "Steel Trust," in contracting for the *Wolvin*, a vessel far exceeding the 500-foot limit, was a most pronounced innovation; and the showing to be made by this new monster in actual service will be awaited with the greatest interest by every person having to do with our interior commerce.



CARGO HOLD OF NEW LAKE STEAMER *A. B. WOLVIN.*

The new mistress of the unsalted seas is 560 feet in length, 56 feet breadth of beam, and 32 feet deep. In order to give free play for the automatic ore unloaders previously mentioned, all the propelling machinery, including the engines and boilers, is at the stern, and the entire main portion of the vessel is given over to freight storage space—one monster apartment extending, without bulkheads or partitions of any kind, for a continuous length of 409 feet. This hold is in the form of a hopper with sloping sides, so that the storage area has a width of 43 feet at the top and only 24 feet at the bottom. The space between the sides of the ship and the sides of the hopper, is utilized for water ballast; and these compartments have a capacity of 8,000 tons of water.

The hold of the *Wolvin* is capable of accommodating about 500,000 cubic feet of cargo, which is equivalent to more than 400,000 bushels of grain or 12,500 tons of coal. To enable the huge clam-shell buckets of the automatic unloaders to descend readily to all parts of the cargo space, the deck is pierced with thirty-three openings or hatches each 33 feet in length and 9 feet wide. These are placed so close together that the automatic scoops can do the entire work of unloading, instead of it being necessary, as in the case of all vessels heretofore constructed, to employ human assistants to drag the ore within reach of the iron jaws of the machines.

When fully loaded, this immense vessel will travel at a speed of nearly twelve miles an hour, power being provided by

gigantic quadruple-expansion engines of 2,000 horse-power at 80 revolutions per minute, to which steam is supplied from immense water-tube boilers working at a pressure of 250 pounds per square inch. There is storage space for 360 tons of coal, so that the big burden bearer can make a journey of considerable length without delaying to replenish the fuel supply.

All the adjuncts of the twentieth century ocean-going merchant vessel are provided. There are two separate electrical plants for lighting the vessel, so that, in case of accident to one, the craft would not be left in darkness. Powerful pumps are provided for use in case of fire; the heavy steel hatch coverings are moved back and forth by steam power; and small engines supply the energy for hoisting or lowering the two 8,000-pound anchors.

The *Wolvin* is not designed for use as a passenger steamer in any sense of the word; but there are provided in the forward part of the ship, under the pilot house, five very handsome staterooms for the use of the owners and their guests who may wish to travel on the big craft. There are a private galley and a private dining room for the use of the occupants of these apartments. The ship's officers are accommodated on the deck below the passenger quarters; and the engine-room officers are quartered near the engine at the after end of the vessel, where are also located the kitchen, dining room, and mess rooms of the crew.

As significant of the rapid development of lake shipbuilding, it may be noted that this masterpiece of the craft—a vessel weighing 5,500 tons and containing more than 750,000 rivets—is just double the length of the steamer *Cambria*, the first steel vessel ever constructed on the Great Lakes, which went into commission in 1887. It is also worthy of note that this new vessel, which represents an investment of $480,000, will carry a crew of only twenty-five men. The *Wolvin* ranks eighteenth among the world's largest ships; but all those which exceed her in size are ocean-going craft that carry passengers as well as freight. The *Wolvin* has been built at the Lorain, Ohio, shipyard of the American Shipbuilding Company, perhaps the best equipped shipbuilding plant on the Great Lakes.

The Education of Technical Men

What Should be Expected of the Technical School and of Its Graduates

THE TENDENCY recently developed, toward careful, critical analysis of educational methods and opportunities by various technical societies and publications, is to be strongly commended. Such papers as that read by Mr. Geo. A. Damon before the Western Society of Engineers, quoted largely in the May issue of THE TECHNICAL WORLD, must collectively go far toward settling the much mooted question of the place the technical graduate should hold in the eyes of the various professions concerned.

A recent article in the editorial columns of *Marine Engineering*, presumably from the pen of Professor Durand, Acting Director of Sibley College of Engineering, Cornell University, has given a decidedly clear statement concerning the status of the technical graduate and the relations of the school, the graduate, and the public. An abstract is given below:

Value of the Technical Graduate

The time when the graduate of the technical school was without standing in the field of engineering practice is gone.

Those who are in charge of the organization of industrial and engineering enterprises have found that the technical graduate is of definite economic value, and that the possibilities in the proper use of such a man are too great to be safely ignored. To gain the best results from such material, however, there must be a clear understanding of the true function of the technical school; and the graduates must not be expected to exhibit capacity and training which the school cannot be fairly called upon to give them; or, at least, the lack of such capacity or training should not be laid up against the school.

Function of the Technical School

Broadly speaking, it is the function of the school to supply an opportunity, and to measure the extent to which the student avails himself thereof, certifying by a diploma to those who have, to a satisfactory degree, measured up the opportunities offered. The school cannot supply brains, or industry, or ambition, or other qualities essential to success, nor can it force the student to learn if he does not so choose. It should, however, and does, refuse to certify to the man in cases which fall below the standard assigned.

It is the further duty of the school, in selecting among the wide range of activities which enter into the engineer's profession, to take those subjects which are fundamental and common to the profession at large, and, furthermore, to give primarily such instruction and training as the student cannot well obtain in the field of actual practice, or the attainment of which could be achieved only at the expense of a disproportionate effort.

The Meaning of a Diploma

The possession of a diploma from a technical school means primarily, therefore, that the holder has had certain opportunities for becoming acquainted with the fundamental principles of engineering, and with their application to various problems of a broad and representative character; and, furthermore, that he has availed himself satisfactorily of these opportunties, and has therefore laid the foundation for success as an engineer. The recent graduate must not be assumed, by that fact alone, to be a man of affairs, a financier, a capable organizer and administrator of business ventures, a close estimator of production costs, an adept at handling labor and dealing with the many perplexing questions which the personnel of a large enterprise may involve; nor, in general, can he be safely assumed to have in any marked degree those qualities which are usually the results of actual experience with engineering and business life.

On the other hand, he may be fairly assumed to know how to do all sorts of things connected with the routine computations and determinations involved in engineering practice. He may be fairly assumed to know how to go to work to study new problems, and how to undertake to find out the unknown regarding questions which may arise in his daily work.

The What and How of Engineering

In a general way most engineering work consists in determining the answers to two sets of questions: *What?* and *How?* What shall be done? and, How shall we do it? As a rule the former questions require more of judgment and experience for their consideration than the latter. Once the "what" is determined, the "how" of the design and installation is often a relatively simple and routine matter. While questions of the latter character often involve elements requiring broad experience and mature judgment, met in a general way, past experience can be more easily and directly applied to such problems, and the recent graduate can as a rule be more profitably employed in the early stages of his experience in connection with questions relating to the "how" rather than the "what."

Advantages of Technical Instruction

The present status of the technical graduate shows that, in the opinion of those best fitted to know by direct use, the average man does gain in capacity for usefulness in engineering work by following a regular course of technical instruction; and any industrial undertaking in which the maximum possibilities of the present age are to be fully developed and utilized, must recognize this fact. There may be exceptions to the

broad rule. Some men might have their capacity for usefulness decreased rather than increased. Genius knows no law or limitation, and will assert itself quite independently of opportunities which the average man may well employ. The fact still remains, however, that the average individual will profit by using opportunities which may be quite needless for the rare genius.

Effectiveness of the Schools

The further question still remains, as to the efficiency with which the technical colleges are doing the work which may thus be expected of them.

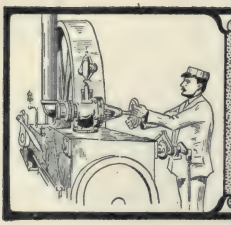
The engineer, it should be remembered, stands as the mediator between the energies of nature and the needs of modern civilization. His primary function is to transform such energies from the non-available form, and to use them in the fulfilment of the manifold demands of the industrial world. It follows that the education of the engineer must necessarily have a twofold aspect: that which relates, first, to the fundamental transformations of energy; and, second, to its use in detail for the needs of modern industry. The former must be fundamentally scientific; the latter operative, economic, industrial, and practical.

If any general criticism can be made on the tendencies of engineering education during the past 20 years, it may be said that the practical and economic aspects have been somewhat neglected in comparison with the scientific and theoretical. With the industrial tendencies of modern times, the keenness of competition, and the advance of the economic to the front rank as a controlling feature in all industrial operations, the increasing importance of the practical side of the engineer's activity can no longer be doubted. It becomes, therefore, nothing less than the plain duty of every engineering school to give not only such fundamental and theoretical training as shall familiarize the student with energy in its various forms, and with the means available for its transformation and adaptation to specified uses, but also to give him such fundamental and organizing principles regarding the economic uses of energy and its application to the needs of civilization, that his keenest enthusiastic attention will be directed to observations along practical and industrial lines.

The Typical Engineer

Having in view the general facts above noted, it seems to follow that the typical engineer of the immediate future will be to an increasing extent a man of affairs, a man with some capacity and training in the administration and conduct of business and industrial enterprises, a man fully alive to the economical and practical aspects of his field of work. In fact, there are now awaiting men of such large capabilities, positions of wide responsibility and influence, and such men must necessarily enter into the world's work as a larger factor than the man who deals with a single aspect of his profession, necessary as the latter may be. It cannot be expected that every man will reach such positions of wide influence and responsibility, but as they are open to the engineer of proper capacity and training, the engineering college should surely take cognizance of such fact, and strive to give to the world men qualified for these positions.

The situation in brief is this. We have, on the one hand, the field of engineering industry, and on the other the technical college occupied in the training of men for lives of activity and usefulness in this field. It is very sure that while the principles of engineering are unchanging, the practice of the art has during the past few years undergone most radical and important developments. Have the developments in technical education kept pace with these developments? We may be permitted to doubt it, and to urge that the one great need of technical education at the present day is a closer contact and more accurate adjustment with the field of engineering practice. We may say, otherwise, that the aim of the technical college should be to make its education more *practical* in quality, implying by this term not necessarily more handicraft skill, but rather a more carefully studied adaptation of its instruction to the present and immediately prospective demands in the field of practical engineering work.



ENGINEERING PROGRESS

The Auto-Boat

THE accompanying illustration shows the new auto-boat *Japansky*, winner in Class R at the first American auto-boat contest, recently held at Port Washington, Long Island, under the auspices of the Manhasset Bay Yacht Club. The auto-boat *Japansky* is owned by Mr. F. H. Waldorf, and has a racing rating of 70.65 rate of 20.3 miles per hour. This is at the rate of 17.6 knots per hour, the entire course being easily covered in 1 hour 6 minutes 29 seconds.

The hull, as well as the engine equipment, was constructed at Morris Heights, N. Y., by the Gas Engine & Power Company and Messrs. Charles L. Seabury & Company. The auto-boats entering this first American contest were divided into

AUTO-BOAT *JAPANSKY.*

Hull of Spanish cedar. Length on water line, 38.93 feet; Motor, 4-cylinder 4-cycle "Speedway;" Horse power, 40.99; Rating, 70.65. Owned by F. H. Waldorf.

feet, the water-line measurement being 38.93 feet. This boat has a hull of Spanish cedar, and is provided with a four-cylinder four-cycle "Speedway" motor of a capacity of 40.99 H. P. This little craft is said to have easily carried off the honors of the day; and it is claimed that the result of the first American auto-boat contest has demonstrated the fact that this class of sport is bound to occupy a most important place among those of national interest. The *Japansky* traveled over a course of 19½ knots at the two classes:—Class R, for boats between 70 and 80 feet long, in which class the above-described boat was entered; and Class S, for boats over 60 feet and not over 70 feet long. It is most surprising to note the facility with which the auto-boats are handled. They can be stopped and started quickly, and can turn with ease in a very small space under rapid headway. There is every reason to believe that auto-boat contests will take their place along with automobile race meets, and that they will surely equal in

interest the old-time bicycle meets of world-wide renown.—F. C. PERKINS.

An All-Year-Round Auto.

THE popularity of the automobile is such that many different designs have been invented to run on wheels, but the vehicle illustrated in the accompanying photograph is designed to travel over the snow or the earth according to the season. It was arranged by removing the two front

ALL-YEAR-ROUND AUTOMOBILE.
Equipped with Interchangeable Front Wheels and Runners.

wheels and substituting sleigh runners. The weight of the auto rests upon the hind wheels, which are connected with the shaft of the machine. These are sufficient to propel it over the snow at a rate of speed which is actually much more rapid than if it moved on wheels merely. The auto here pictured is owned by Mr. J. K. Flood, of Hart, Michigan, who uses it throughout the winter, frequently going through snow over a foot in depth.—D. A. WILLEY.

A Self-Dumping Car

IN MODERN RAILROAD CONSTRUCTION in sections where the topography is such as to necessitate the crossing of deep valleys, the track rests, as far as possible, upon a solid foundation made by filling the depression beneath with earth, rock, and other material. Some of these "fills," as they are called, in the West, are notable for their depth. On the Union Pacific Railroad, for example, one was recently completed which is over 150 feet in height from the center of the valley crossed by the line, to the rails.

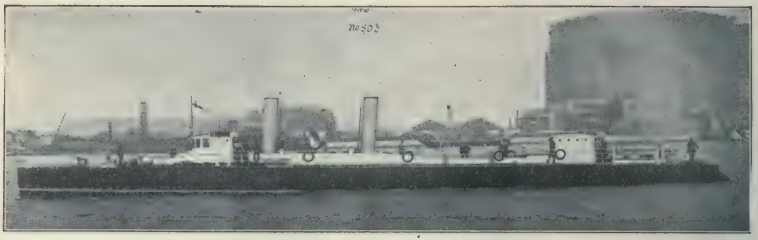
In dumping the material for this purpose, what is known as a "self-dumping" car is used, which is remarkable for the amount of labor that it saves. This car is built of steel, with its lower half of a V-section. Each side is hinged, and may be swung in and fastened, or released, at the will of the operator. The movable framework holding the sides in place is connected with valves or "dump cylinders" operated by compressed air, the ordinary supply furnished for the air-brakes being usually sufficient to operate them.

The car can be arranged so as to open on one side or the other or on both sides. When it is loaded, it is run out upon the trestle or false work, and, by merely pulling the "dumping lever," as it is called, the sides are opened, and the contents of the dumper are thrown in the center of the track or on either side as desired. Only one man is required to empty a train of five or six cars after the mechanism for directing the motion of the contents has once been adjusted. By coupling the air hose to the dumping cylinder on the end car, one man, by shifting a lever, can dump a train of half a dozen or more cars.

By utilizing this form of car, 10 to 25 cubic yards can be thrown on the embankment from each side in merely the

TRAIN OF SELF-DUMPING CARS ON TRESTLE OVER FILL.

time required for the material to pass out—usually a few seconds. As the lower portion of the false work is filled, an addition to the trestle is constructed, and more cars added to the dumping train. If more material accumulates on one side



ENGLISH TURBINE YACHT *TARANTULA.*

of the trestle than on the other, it is necessary only to keep one side of the car closed and thus divert all of the filling to the lower, shallower part of the bank.

When the level of the roadbed is reached, the track is laid with rails of the usual size, and the cars are utilized to ballast it. Loaded with rock or gravel, they are hauled over the rails to the de-

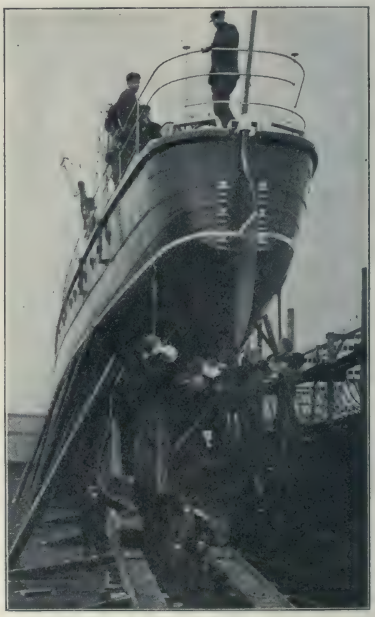
SELF-DUMPING CAR IN OPERATION.

sired point; and by the single motion of the lever, the material can be thrown, not only on one side of the rails to the required distance, but also between them so evenly that a few minutes' work with a shovel is sufficient to place the roadbed in condition for regular service.

An interesting feature in connection with the ballasting is the rapidity with which the work is performed. In case time is precious, the material can be discharged from either or both sides while the locomotive is pulling the cars at a speed ranging from five to twelve miles an hour. For completing the surface of the roadbed, it was found, in the work above referred to, that the distribution was very satisfactory even at the latter rate of speed.—D. A. W.

A Turbine-Driven Yacht

THE STEAM TURBINE YACHT, as well as the turbine steamer, is attracting a great deal of attention at the present time on account of the very high speeds which these vessels are able to attain, and the high efficiency of the peculiar modern device used to operate the propeller.



TURBINE YACHT "TARANTULA."
Showing the three propeller shafts.

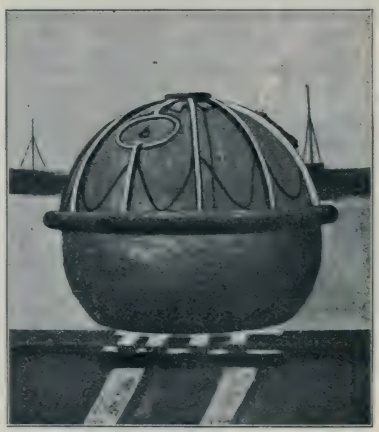
The accompanying illustrations show the steam turbine yacht *Tarantula* under construction and in operation, and the arrangement of the three propellers employed on each shaft. The view of the boat before launching gives an excellent illustration of the three propeller shafts, each of which is equipped with three screws. This boat was constructed for Colonel McCalmont under the superintendence of Messrs. Cox & King, the well-known yacht men at the English shipyards of Yarrow & Company, of Poplar.

TURBINE YACHT *TARANTULA*,
Showing how the propellers are mounted on the shafts.

The vessel is 160 feet long, with a 16-foot beam; and is propelled by steam turbines constructed at Wallsend-on-Tyne by the Parsons Marine Steam Turbine Company, which are supplied with steam from Yarrow boilers. This steam turbine yacht is of particular interest as it is identical in construction with the first-class English torpedo-boats built at these yards, with the exception of the propeller machinery, while the lines of the hull and the scantling are the same. The boilers used on the first-class torpedo-boats are identical with those installed on the *Tarantula*, so that the only difference lies in the steam turbine propelling machinery. The total power developed by torpedo-boats of this size constructed at these yards, is about 2,000 H. P., the engines being of the reciprocating triple-expansion type. The form of the propellers used on the *Tarantula* was adopted on account of the high speed developed by the steam turbines employed. —F. C. P.

A Life-Saving Globe

CAPTAIN DONVIG of Copenhagen has constructed a globe-shaped life-saving apparatus that bids fair to take the place of the lifeboats carried on steamers. He conceived the idea while watching an iron water tank buffeting the winds and waves during a terrific storm. After



DONVIG'S LIFE-SAVING GLOBE, READY FOR IMMERSION.

years of study and work, the Captain believes he has invented a perfect live-saving apparatus. Recently a most interesting experiment was made in the presence of a number of naval officers. The globe with its living cargo was cast from the wharf into the sea. At first it sank, but after a few seconds appeared above

DONVIG'S LIFE-SAVING GLOBE.
Sail and Ventilating Tube Raised.

water. The port holes were then thrown open. One of the crew adjusted a sail, and guided the globe by means of a rudder. Similar successful experiments were made in the open sea.

A committee of experts appointed by the Norwegian Government stated in their official report, that, "with the exception of sailing and managing, the life-saving globe is superior to any modern ship's lifeboat; and, when seamen and passengers have the advantages of the globe explained to them, they will, without doubt, choose to go in the globe in preference to a ship's lifeboat."

In the U. S. consular report the apparatus is described as follows: It is constructed of 3-16-inch steel plates, and has the form of a globe from which a segment is cut off, the flat part forming the bottom, which is double, the outside one being 5-16-inch thick. It is furnished with the following outfit: A fender of 16-inch coil rope laid around the largest part of the globe; an anchor with 100 fathoms of 1½-inch steel wire rope; wooden grating on top of the inner bottom; straps and loose reindeer-hair padding provided for 16 men; bilge pump; closet bucket; rudder and tiller (of steel); sails and oars.

Around the interior of the globe are a series of lockers, which serve as seats for the crew. In these lockers can be stored 14 cubic feet of provisions. In the space between the double bottom 560 liters (148 gallons) of fresh water can be stored. Through the top of the globe a 12-inch ventilating pipe can be raised from the inside, to a height of 5 feet above, and it can be lowered so that the top end is flush with the top of the globe. This pipe is fitted with cover and packing in the top for quick opening and closing to secure ventilation when at sea.

In the upper part of the globe, manholes are fitted which can be opened and shut from within. The surroundings can be observed through small glass lights fitted in the sides.

Lifting Magnets

An Important Use of the Electro-Magnet not Popularly Understood.

THE HANDLING of steel or iron products with the aid of electro-magnets is of great interest to those devising economical methods in steel mill operation.

So far as the writer knows, there is no standard authority on this subject, and all the information possessed by anyone has been acquired by actual experience.

The electro-magnet can be adapted to a great variety of uses, and new schemes are being brought up every day. It is common practice now to handle plates, billets, blooms, and slabs, as these make a very simple proposition; but the handling of pig iron, steel, and cast-iron scrap and pipe brings complications into the question, which, while they have been successfully overcome, have used up a

great deal of "gray matter" in the solving.

One of the largest steel mills in the Central West has been using lifting magnets for the past five years, in the handling of its plates and billets; and a former general manager recently made the remark that he "would not take $50,000 and do without the magnets," as they had saved him a great deal more than that in time and labor.

To any one familiar with the handling of billets, it would hardly be necessary to mention the difference in time consumed between blocking up and putting a chain around four or five billets, and the dropping of a magnet on the top of the same number and lifting them instantly.

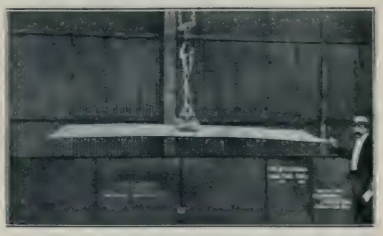
In the handling of plates it is possible to pick up three or four at a lift, and to deposit them in three or four cars or piles as may be desired. If there are four plates on the magnet, the opening of the line switch for an instant will release the bottom plate, the residual magnetism holding the others until the

Lifting Magnet at Work.

switch has been closed. By repeating the operation, each plate can be dropped separately. With four plates on the magnet, if the switch is opened permanently, the plates will drop in 1-2-3-4 order with about eight inches of space between them.

It is now possible to handle from 1,500 to 2,000 lbs. of machine-, sand-, or chill-cast pig iron at a lift, with a specially constructed magnet that has recently been placed on the market. The magnet holds from 25 to 40 pieces, and at some points they string out two or three lengths like sausages.

To give an idea of the time and labor saved, one instance of actual results obtained may be cited. In one mill in the Pittsburg district it formerly required twelve laborers and a craneman to unload the steel as it arrived at the mill. Lifting magnets were installed one year ago, and now two laborers and a crane-



Lifting Magnet at Work.
Contact of man's hand with plate shows absence of all danger from shock.

man accomplish the same work in one-third the time, which amounts to one-fourth the number of men doing three times the work with the aid of a pair of magnets.

In the forging shop of a large bridge plant, magnets are being used on a charging machine for charging bars into the heating furnace, three magnets being arranged on a spreader so that the bars are lifted at three points. The front magnet almost enters the door of the furnace so that it is necessary to wind the coil with asbestos-insulated wire so that the heat will not affect it. The flames shoot out several feet from the door when it is opened, so that the magnet is completely enveloped every time it charges or draws a bar; but the fireproof insulation protects it from injury.

The handling of wrought-iron pipe with magnets looks very simple at first glance; but it is not so simple in the solving as it appears. The trouble here is that the walls of the pipe are so thin that it is hard to obtain the requisite pull to lift the weight.

This can better be explained by the illustration of a practical experiment. Take, for instance, a magnet capable of lifting 6,000 to 10,000 lbs., and, connect-

ing it on the circuit, place a piece of sheet iron about 3 in. by 12 in. on the poles; this can be pulled off with hardly any effort. Take, however, another piece 3 in. by 12 in. by ⅛ in. and it will require a much stronger pull before it can be removed. Now take a piece 3 in. by 3 in. by 12 in. and it will be found impossible to move it with a straight pull. This experiment shows that the strength of the magnet remains the same, but the holding power increases as the thickness or mass increases.

Lifting Magnet Used for Shipping Purposes.

It is not practicable in all cases to use a lifting magnet—for instance, where it is necessary to carry material over men's heads, or in the lifting of material that would be injured by a fall should a fuse blow or the breaker come out at the power house. There are two ways by which this trouble can be obviated and the magnets made comparatively reliable. One method is to run a separate circuit from the generators connecting it inside the breaker, so that as long as the generator is running and the magnet line is safe the magnets will hold. The other method is to carry a small storage battery on the crane, arranged with an automatic switch so that the batteries will be thrown onto the magnet circuit the instant the power happens to fail. There is a safe manufacturing firm now using magnets for handling safes, and they employ the first-named method.

The handling of fine steel scrap, such as shear-needles, punchings, etc., has always been an exasperating problem, as it has been demonstrated by actual experience that a magnet with a pole surface of 864 square inches cannot lift more than 200 lbs. of this class of material. Since the advent, however, of the pig magnet already mentioned, it is possible to lift from 1,000 to 2,000 pounds.

A question often asked is, Will a man get shocked if he touches a plate held up by a magnet. In answer it is necessary merely to explain to the questioner that magnetism is not of a shocking nature, and, as the electric conductors are perfectly insulated, there can be no danger.
—John S. McKee.

Systems of Piping

Various Arrangements of Pipes and Radiators in Heating Systems

By CHARLES L. HUBBARD, M. E.

THERE are three distinct systems of piping, known as the "two-pipe system," the "one-pipe relief system," and the "one-pipe circuit system," with various modifications of each.

Two-Pipe System

Fig. 1 shows the arrangement of piping and radiators in the two-pipe system. The steam main leads from the top of the boiler, and the branches are carried along near the basement ceiling. Risers are taken off the supply branches, and carried up to the radiators on the different floors; and return pipes are brought down to the return mains, which should be placed near the basement floor, below the water line of the boiler. Where the

building is more than two stories high, radiators in similar positions on different floors are connected with the same riser, which may run to the highest floor; and a corresponding return drop, connecting with each radiator, is carried down beside the riser to the basement.

A system in which the main horizontal returns are below the water line of the

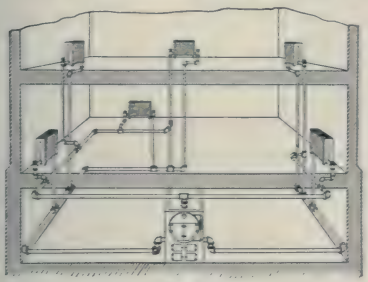


Fig. 1.

boiler, is said to have a "wet" or "sealed" return. If the returns are overhead and above the water line, the system has a "dry" return. Where the steam is exposed to extended surfaces of water, as in overhead returns, when the condensation partially fills the pipes, there is likely to be cracking or "water hammer" due to the sudden condensation of the steam as it comes in contact with the water. This is especially noticeable when steam is first turned into cold pipes and radiators, and the condensation is excessive. When dry returns are used, the pipes should be large, and have a good pitch toward the boiler.

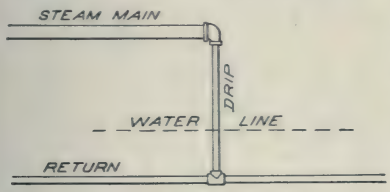


Fig. 2.

In the case of sealed returns, the only contact between the steam and standing water is in the vertical returns, where the exposed surfaces are very small (being equal to the sectional area of the pipes) and trouble from water hammer is practically done away with. Dry returns should be given an incline of at least one inch in 10 feet; while for wet returns, one inch in 20 or even 40 feet is ample. The ends of all steam mains and branches should be dripped into the returns.

If the return is sealed, the drip may be directly connected, as shown in Fig. 2; but if it is dry, the connection should be provided with a siphon loop, as indicated in Fig. 3. The loop becomes filled with water, and prevents steam from flowing directly into the return. As the condensation collects in the loop, it overflows into the return pipe and is carried away. The return pipes in this case, of course, are filled with steam above the water; but it is steam which has passed

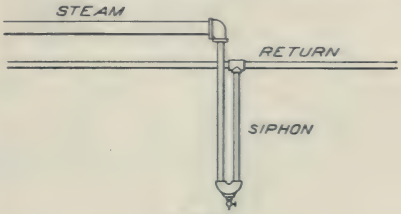


Fig. 3.

through the radiators and their return connections, and which is therefore at a slightly lower pressure, so that if steam were admitted directly from the main, it would tend to hold back the water in more distant returns and thus cause surging and cracking in the pipes. Sometimes the boiler is at a lower level than the basement in which the returns are run, and it then becomes necessary to establish a "false" water line. This is done by making connections as shown in Fig. 4.

It is readily seen that the return water, in order to reach the boiler, must flow over the loop A, which raises the water line, or seal, to the level shown by the dotted line. The balance pipe is to break the seal as the water flows over the loop, and thereby to prevent any siphon action, which would tend to drain the water out of the return mains after a flow was once started.

One-Pipe Relief System

In this system of piping, the radiators have but a single connection, the steam

flowing in and the condensation draining out through the same pipe. Fig. 5 shows the method of running the pipes for this system. The steam main, as before, there will be no pressure to force the water back to the boiler. A check valve should always be placed in the main return near the boiler, to prevent the water

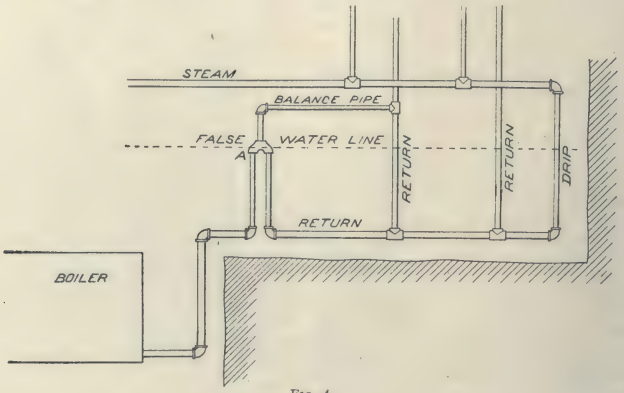


Fig. 4.

leads from the top of the boiler and is carried to as high a point as the basement ceiling will allow; it then slopes downward with a grade of about 1 inch in 10 feet and makes a circuit of the building or a portion of it.

Risers are taken off the top, and carried to the radiators above, as in the two-pipe system; but in this case the condensation flows back through the same pipe, and drains into the return main near the floor, through drip connections, which are made at frequent intervals. In a two-story building, the bottom of each riser to the second floor is dripped; and in larger buildings it is customary to drip each riser that has more than one radiator connected with it. If the radiators are large and at a considerable distance from the next riser, it is better to make a drip connection for each radiator. When the return main is overhead, the risers should be dripped through siphon loops, but the ends of the branches should make direct connection with the returns. This is the reverse of the two-pipe system. In this case the lowest pressure is at the ends of the mains, so that steam introduced into the returns at these points will cause no trouble in the pipes connecting these with the boiler.

If no steam is allowed to enter the returns, a vacuum will be formed, and from flowing out in case of a vacuum being formed suddenly in the pipes.

One-Pipe Circuit System

In this case (see Fig. 6), the steam main rises to the highest point of the basement, as before; and then, with a considerable pitch, makes an entire circuit of the building, and again connects with the boiler below the water line.

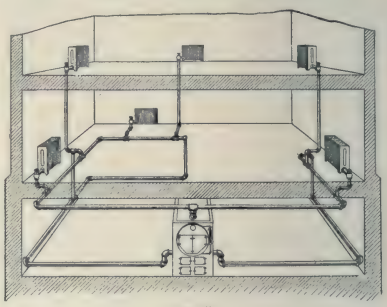


Fig. 5.

Single risers are taken from the top; and the condensation drains back through the same pipes, being carried along with the flow of steam to the extreme end of the main, where it is returned to the boiler. The main is made large, and of the same size throughout its entire

length; it must be given a good pitch to insure satisfactory results.

One objection to a single-pipe is that the steam and return water are flowing

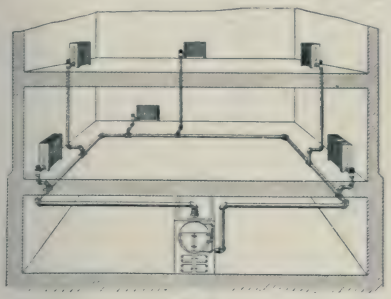


FIG. 6.

in opposite directions, and the risers must therefore be made of extra large size to prevent any interference. This is over-

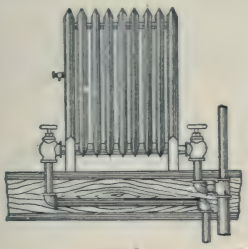


FIG. 7.

come in large buildings by carrying a single riser to the attic, large enough to supply the entire building; and then branching, and running "drops" to the basement. In this system, the flow of steam is downward as well as that of water. This method of piping may be used with good results in two-pipe systems as well. Care must always be taken that no "pockets," or low points, occur in any of the lines of pipe; but if for any reason they cannot be avoided, they should be carefully drained.

Pipe Connections

Figs. 7, 8, and 9 show the common methods of making connections between the supply pipes and the radiators. Fig. 7 shows a two-piece connection with a riser; the return is carried down to the main below. Fig. 8 shows a single-pipe

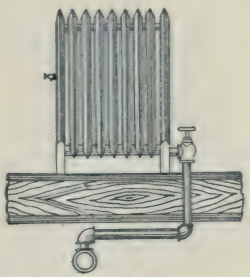


FIG. 8.

connection with a basement main; and Fig. 9, a single connection with a riser.

Care must always be taken to make the horizontal part of the piping between the radiator and riser as short as possible, and to give it a good pitch toward

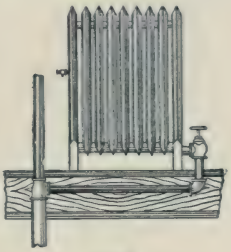
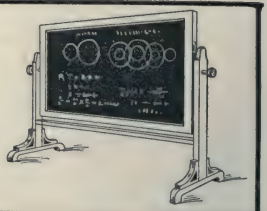


FIG. 9.

the riser. There are various ways of making these connections specially suited to different conditions; but the examples given serve to show the general principles to be followed.

CHALK TALKS



by CARL S. DOW.

Number Six—The Indicator

A FUNDAMENTAL TRUTH in engineering is: Work is equal to Pressure or Force *multiplied by* the Distance through which it acts. Therefore the amount of work done by a steam engine may be found by multiplying the pressure acting on the piston by the distance through which the piston moves. The distance is easily found, since the number of strokes can be counted and the length of the stroke measured; but the steam pressure varies at every point of the stroke. To find the pressure at various points in order to get the average pressure, engineers use a device called the *indicator*.

The Instrument

The indicator shown on the blackboard consists of a cylinder A, in which is the piston B, and a drum D on which is wrapped the paper for recording the diagram. The cylinder is placed in communication with the steam engine cylinder by some form of connection at S. The cord C, which causes the drum to rotate on its axis, is fastened, through some form of reducing motion, to the crosshead of the engine, as this part moves exactly the same as the piston.

In order to measure the intensity of pressure, a spring of known strength or elasticity is placed above the piston B. The strength of the spring is such that the pencil P moves vertically on the drum one inch for a given pressure, such as 40 pounds, 60 pounds, etc. To make the lines on the diagram proportional to the length of stroke, the drum is so arranged that it rotates in an arc of between 180° and 300° for a stroke. In other words, the drum oscillates on its axis, but does not make a complete revolution.

The action is as follows: Steam enters the indicator cylinder, and acts on the indicator piston B, the pressure per square inch being at all times the same as that in the engine cylinder. While the pencil vibrates according to the variation in steam pressure, the drum is revolving with the movement of the engine piston. The levers are arranged about as shown, in order that the pencil may move vertically in a straight line.

Meaning of Lines Drawn by the Pencil

In order to see clearly the lines drawn by the pencil, let us assume the paper unwrapped from the drum and laid out flat, as shown in Fig. 1. Let us suppose the cord C to be disconnected; under this condition the drum will not move. If steam is admitted to the indicator cylinder, the spring will be compressed, and the pencil will rise and make a line such as A B, Fig. 1. Now connect the cord to the crosshead, and admit a constant pressure of steam to the indicator. The constant pressure will hold the pencil stationary, and as the drum revolves a horizontal line C D is drawn. We can thus deduce the two important facts:

Vertical lines represent a change in pressure and no movement of the engine piston.

Horizontal lines indicate a movement of the engine piston without increase or decrease of pressure.

Now, suppose a line such as E F is drawn on the paper. It means that while the engine piston was moving an amount

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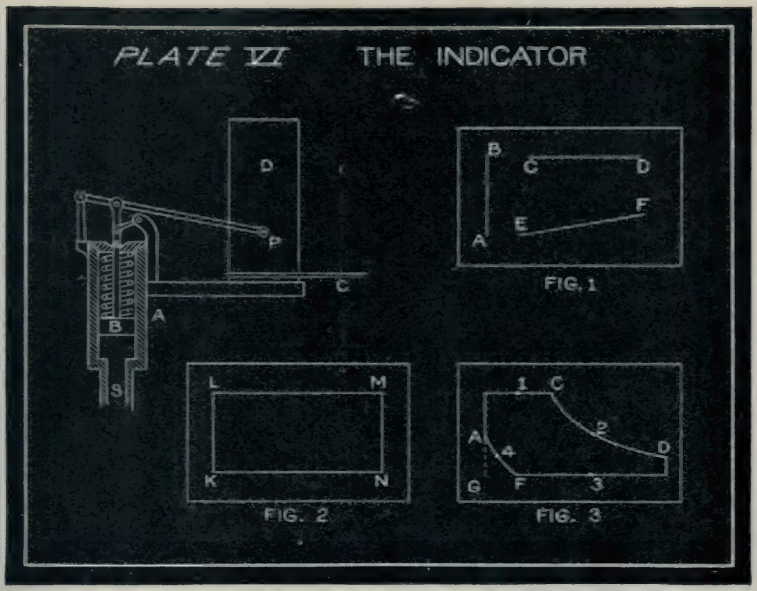

represented by the horizontal distance of E F, the pressure increased by an amount proportional to the difference in elevation of E and F.

Indicator Diagrams

Now consider Fig. 2. When steam is admitted to the engine cylinder, the pressure rises when the piston is at the end of the stroke, while the piston has little, if any, movement. This may be represented by the line K L. The supply of steam entering the cylinder forces the piston along; and, as the pressure is constant, we get a line such as L M. At the end of the stroke, the steam that has done work must leave the cylinder in order to make room for the incoming steam. When the exhaust valve opens at the end of the stroke, the pressure drops suddenly (see M N), and the returning piston forces the steam out at nearly constant pressure, as shown by the line N K.

In the actual engine, the admission of steam is stopped at about half-stroke. This is shown at C, Fig. 3. The constant pressure is interrupted at this point. As no more steam is admitted, the pressure of the steam in the cylinder gradually falls as the piston increases the volume. This is shown by the line C D. Again, at the end of the return stroke, the valve closes the exhaust, and the entrapped steam is compressed. When steam is compressed, its pressure increases. While the piston moves from F to G (horizontally) the pressure increases gradually to A, at which point the steam is again admitted.

By considering various points, such as 1, 2, 3, 4, etc., it is easy to find the exact position of the piston in the cylinder, and the pressure acting at that point. Thus, in point 2, the engine piston has moved a distance A2 from the left-hand end of the cylinder, and the pressure is proportional to the vertical distance of 2 above a zero or base line. The base line is found by revolving the drum before admitting steam to the indicator. As the pressures at all points can be found, there are various methods of finding the average pressure, which is the quantity needed for calculating the horse-power.

Life Stories of Successful Men

Thomas A. Edison

By HENRY M. HYDE
Editorial Writer on the *Chicago Tribune*

A MAN from New York was traveling in Egypt. By way of amusement he asked his ignorant donkey boy if he knew the name of the President of the United States. The boy shook his head.

"Do you know who Edison is?" persisted the traveler. The boy smiled, nodded, and pointed to the electric light which glowed in front of the hotel.

Everybody is more or less familiar with the career of the "Wizard of Menlo Park," the "young man who kept the path to the Patent Office hot with his foot-steps," the inventor who has taken out 786 patents in the United States alone; the man to whom the world owes the incandescent light, the phonograph, the duplex telegraph, and a hundred other useful devices. But the story of his career can never be so familiar as to lose its power of encouragement and inspiration to other young men who are determined to win success in the face of difficulties.

Edison's father made shingles for a living. His mother had been a school teacher. The one taught him to use his hands; the other, to use his head. He went to school little. At thirteen he went to work as a train-boy, selling papers and cigars on the Grand Trunk Railroad. As a "train-butcher" he was a success. He was enterprising, self-reliant, and by no means backward. He got to know most of the men employed on the road along his "run."

Presently, from selling newspapers, he began to print a little paper of his own. He called it *The Grand Trunk Herald,* and it was printed in one end of a combination baggage and smoking car, which he had fitted up with a little press and some old type. The files of that early paper are sufficient proof of the fact that Edison was weak on grammar and strong on the gossip of the road.

In editing a paper, he became interested in printed books. One day he went into the Detroit (Mich.) Public Library; and there, with no teacher to guide him, the boy began in an amusing and, at the same time, a characteristic way. He picked out a shelf on which stood the thickest books in the Library, and decided to read them all through. If he could conquer these biggest books, the rest should be easy. You see, he was never afraid of work; and he had the courage to tackle the hardest part of the proposition first.

He found that he could not understand a great deal of what he read. Many of the words were beyond him; and the thought in such volumes as Burton's "Anatomy of Melancholy" was far too deep and complicated for his untrained understanding. But he stuck at the task until he had finished a careful reading of a whole shelf, fifteen feet long, packed with bulky volumes. The lesson of perseverance was already learned.

In this undirected reading he had picked up a great deal of general information, and had got a hint or two on some subjects that deeply interested him. One of these was chemistry. In the Public Library he found an old chemistry; and that book, with the wonderful statements it contained about such familiar things as light, air, fire, and water, greatly excited him. He wanted to see for himself if what the book said was true. So, with the money earned as a train boy, he bought some cheap chemicals and second-hand apparatus, and set to work. He fitted up his laboratory in one corner of his printing office, which occupied the unused end of that baggage car. In order to keep the trainmen from

disturbing his chemicals, he pasted a "poison" label on every bottle. But one day he dropped a bottle of phosphorus on the floor of the car. It took fire; in rushed the conductor, furious at the carelessness of the train boy, and threw every bottle out onto the right of way. In his anger, he even tossed the printing press out after the glassware.

Edison was smart enough to know that the conductor was well within his rights. He did'nt get mad, and throw up his job. He simply picked up the pieces, and started a new laboratory and printing office in the cellar of his father's house. The spirit of the future inventor was not to be so easily discouraged.

A few weeks later, Edison saved the life of a little boy—the child of the Grand Trunk station master at Mount Clemens, Michigan. The father was grateful. He had, however, no money to offer as a reward.

"Al," he said—Edison was so called in his boyhood—"I'll teach you to be a telegraph operator, and get you a job that'll pay $25 a month."

"All right," said young Edison. "Let's begin to-night."

At all the stations along the line of his run, Edison had made friends. Most of the operators encouraged him in his ambition to become a telegrapher, and within three months he had learned the business. But it was by dint of almost continual practice.

"All I have accomplished," said Edison a few years ago, "is due to the fact that I have never learned to watch the clock."

As soon as he had learned to be an operator, Edison asked himself the eternal question—Why? By way of answering it, he set up a little telegraph line in his father's house, and experimented a great deal with electricity. Presently he got a job in the telegraph office at Port Huron, Mich., which paid him $25 a month. He had been promised a raise at the end of six months. He did'nt get it, and resigned his job. The station master, whose child he had saved, got him another one, as operator for the railroad over at Stratford, Ontario. At this time, let it be remembered, Edison was a mere boy of fifteen years. One of the rules of the office was that every half-hour he should call up the train despatcher and give him the signal "Six." Edison was all the time experimenting, and it was a great bother to be interrupted every thirty minutes to send that signal. He called his inventive genius into play, and built a little device, attached to the clock, which telegraphed "Six" to the train despatcher's office every half-hour. That device got him into serious trouble. It almost caused

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THOMAS A. EDISON.

From photo by Falk, Feb. 11, 1904, Mr. Edison's Fifty-seventh birthday.

what might have been a fatal collision between two trains, which was averted only through the watchfulness of the engineers. Edison was discharged, but he had learned the lesson of obedience, and he never forgot it afterwards.

For the next five years, Edison was a roamer over the states of the Middle West, easily securing jobs as an expert telegrapher, but not holding them long, because he was always experimenting and trying to invent easier and quicker ways to do things.

At twenty-one this penniless telegraph

operator, who would have laughed at the idea of being called an electrical engineer, went to Boston to take a place in the Western Union telegraph offices there. But, though entirely self-taught, he was already, though he did not perhaps realize it, at the head of his profession. In Boston he found inspiration and encouragement. At night he worked at his key; in the daytime he toiled in a little shop he had fitted up for experimental purposes. He invented and perfected an electrical device for recording the votes in the House of Representatives. It worked perfectly, but there was no demand for such a device, and it has never been utilized. That failure taught Edison the lesson of devoting his attention to inventions which promise to be commercially useful.

In 1869 Edison left Boston, and went to New York as being the center of the business world. He reached the metropolis with no money, and with no work in sight. In fact he was heavily in debt, his Boston experiments having cost more than he was able to pay out of his wages as an operator.

For several days he made the rounds of the telegraph offices and electrical shops, looking in vain for a job. At length, however, his opportunity came; and his technical knowledge, painfully acquired as it had been, made him equal to it.

He was approaching the office of Law's Gold Reporting Telegraph Company one afternoon in the quest of work, when he noticed an excited crowd of men and boys about the door. He learned by inquiry that the stock tickers which sent the reports of the markets to the offices of brokers all over the city were out of order and would not work. There was consequently danger of serious loss; and Mr. Law, head of the company, was standing helpless and half-distracted beside the broken-down instrument. Edison, introducing himself as an expert electrician, pushed himself into the private office, set to work on the apparatus, quickly found the difficulty and repaired it, while Law looked on in wonder and admiration.

The result was an immediate engagement at a salary of $300 a month.

The career of Thomas A. Edison since that time is a commonplace. You can find it in any encyclopedia. But you need read no further to get at the vital facts which made the whole wonderful story a possibility.

Dinner-Pail Philosophy

¶ To conceal truth is to lie in ambush.

¶ Ignorance is the mother of prejudice.

¶ Gratitude is a lively sense of future favors.

¶ Charity begins at home, and often ends there too.

¶ An anarchist is a man who can't stand the prosperity of others.

¶ Is the man at the dime museum who swallows fire a light eater?

¶ Two classes of people are hard to convince against their will—women and men.

¶ People who ask advice, only want their opinions confirmed.

¶ No man whose liver is out of order can look on the bright side of things.

¶ There is a difference between getting on well in life and getting well on in life.

¶ Many men think justice has a leaden heel, and in the end find she has a pointed toe.

¶ A candidate who feels very large and important before an election may feel very small afterward.

¶ Time is a great healer, but give him time enough and you bury all his patience.

Borax in Food Harmful

THAT THE CONTINUED USE of borax as a food preservative constitutes a menace to health, is the conclusion drawn by an official bulletin of the United States Department of Agriculture, based on recent experiments conducted by Professor Wiley and his corps of assistants, or "poison eaters," as they have been called. The general results of the investigation show that, even in doses of not over half a gram a day, boric acid and borax are prejudicial when consumed for a long time. Persons in good health, it is true, may experience no bad effects for some time; but the occasional use of preservatives of this kind in small quantities by the young and debilitated and by the sick, is dangerous. A safe rule to follow is to exclude these preservatives from food for general consumption, and to fall back upon the one method which seems absolutely safe—that of refrigeration.

The external application of borax to cured meats, to preserve them in proper condition during shipment to foreign countries, seems to be free from danger, especially in view of the fact that in cured meats the processes of absorption and diffusion of the chemical are much restricted, and no great penetration ordinarily could occur; but on this point no positive statement is made, owing to insufficiency of data.

On the effect, however, of taking the chemical into the stomach, the bulletin is most explicit:

> No notable effects are immediately produced; but if the small doses (not exceeding half a gram a day) be long continued; there are occasional periods of loss of appetite, bad feeling, fullness in the head, and distress in the stomach. When given in larger doses there is a tendency to a more accentuated form of these symptoms.
>
> The most common symptom developed is a persistent headache, a sense of fullness in the head, with a clouding, to a slight extent, of mental processes.
>
> The effect of the administration of borax in diminishing the weight of the body is well marked. Its continued use decreases the desire for food, and interferes with the digestion of food already in the alimentary canal. The tendency to diminish weight becomes so well fixed that it is not entirely eliminated for several days after the administration of the preservative ceases.

Apparatus for Preventing Seasickness

THE oscillations of a ship in the case of the sea being rough, are doubtless a serious drawback to the physical welfare of both passengers and crew, as well as to the expeditious performance of any work on board. As a matter of course, many endeavors have been made to diminish these oscillations. With regard to the "pitching" motion—alternate end-to-end rise and fall—the results so far obtained have been rather poor. On the other hand, it has been possible to counteract to a certain extent the "rolling" movement or lateral oscillation. Two courses are available in this connection—in one, the period of the oscillation is increased; in the other, its amplitude is diminished. The principal means for limiting the amplitude of oscillation is the use of drift keels and water compartments, and an ingenious device by Thornycroft should be mentioned in this connection. A long period of oscillation, on the other hand, may be obtained by

increasing the moment of inertia, and diminishing the metacentral height; but this method can be resorted to only within rather narrow limits.

An ingenious device, just brought out by a distinguished naval engineer, Mr. O. Schlick, of Hamburg, Germany, seems to be well adapted both to augment largely the period of oscillation of the rolling movement, and to diminish at the same time the amplitude of the oscillation, both effects being based on the gyroscopic action of a fly wheel installed on board, which rotates rapidly. The vertical axis of the apparatus is enabled to perform a pendulating movement in the central plane of the ship. The latter, on account of the rapid, continuous oscillations of the wheel, is rendered insensitive to the effect of wave motion, so as to eliminate practically any rolling movement. As the effect exerted by the device is rather energetic, even with the smallest lateral oscillations of the ship, there will be no propagation of the motion, thus avoiding the production of any strong balancing movement, in contrast with what is observed in the case of drift keels, which are not brought to act before the rolling movements have assumed a high intensity.

As regards the underlying principle of the apparatus, it should be remembered that a rotating body will oppose to any inclination of its axis a resistance the higher as the rotation is more rapid and the weight of the body more considerable. As soon as an inclination of the ship, for some reason or other, is produced at right angles to its longitudinal axis, the fly-wheel frame will be inclined at a considerable angle, thus producing a torque which, in addition to slackening considerably the oscillations of the ship, will greatly diminish the amplitude of the oscillations. Now, as these two factors are alone capable of counteracting the influence of waves with regard to the production of rolling movements, a ship fitted with this device will not be able to perform any rolling movement of appreciable intensity, while the fly-wheel frame suspended in the interior of the ship oscillates violently. The energy transmitted to the ship from the wave motion is thus transferred to the fly-wheel frame, and eliminated by the braking device fitted to the latter. The ship

HERR SCHLICK WITH HIS APPARATUS FOR PREVENTING SEASICKNESS.

body itself will only effect this transmission of energy from the waves, on to the fly wheel, a very slight inclination of the ship being sufficient, as inferred from the theory of gyroscopic motion.

As the forces producing the rolling movement of a ship need not be of an excessive intensity (in fact, it is well known that 20 to 25 men running in proper time from one side to the other of the deck of a large steamer will produce rather considerable rolling movement of the ship), the weight of the apparatus also need not be very great. Mr. Schlick calculates that in the case of a ship 6,000 tons in weight, a 10-ton fly wheel four meters (13.12 feet) in diameter will be quite sufficient. There will therefore be no difficulty in using the Schlick apparatus on ships of moderate dimensions, such as, for instance, cross-channel steamers, on which it will largely contribute to augmenting the comfort of passengers.

The photograph reproduced on the opposite page shows Herr Schlick in his laboratory. On the table is a basin in which floats a model ship equipped with his gyroscopic device.— Dr. A. Gradenwitz.

Kegs Made of Steel

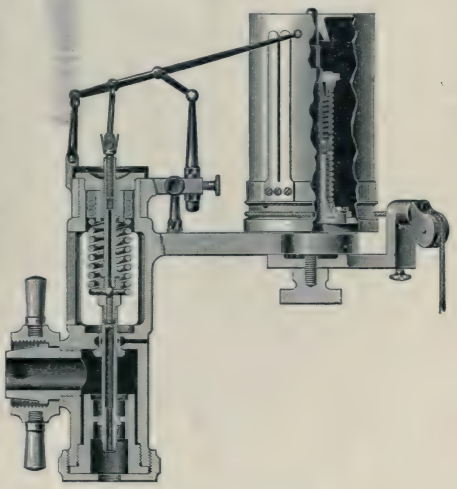
A PROCESS of making kegs out of old steel rails has been invented by Joseph C. Heslop of Joliet, Ill., who believes his invention is to make him wealthy.

In his valise Mr. Heslop carries a small model keg made out of polished steel, which he says will within a few years do away with the old and cumbersome wooden kegs entirely. The steel is only 1-16 of an inch thick and the keg weighs only a few pounds, but its inventor claims that it will stand three times the pressure that a wooden keg will bear, and that it can be made for one-third the price of a wooden keg.

The keg is made in two pieces, the joint being hidden by a steel band. The bunghole is hermetically sealed by a patent contrivance, which requires a key to unlock it. The hole is graduated to fit any size of spigot. Any kind of steel can be used in the construction of the keg, but Mr. Heslop is now using old steel rails. The interior of the keg is covered with a pitch preparation similar to that used in wooden kegs, to keep the beer from tasting of the metal.

Improved Steam Engine Indicator

MANY FIRMS now manufacturing indicators have recently put upon the market a new type in which the spring is exterior. The chief point of difference between this and the inside-spring indicator, is that formerly the spring was entirely enclosed, while now it is exposed to view.



Outside-Spring Indicator.

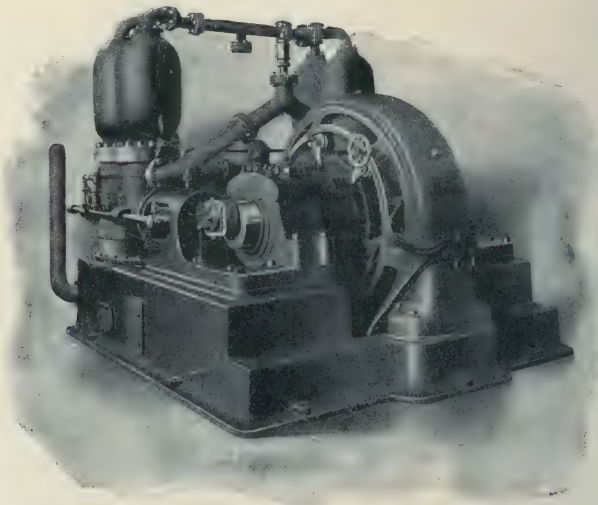
The accompanying illustration shows a section of the outside-spring indicator as manufactured by the Star Brass Manufacturing Company, of Boston, Mass. As will be seen from the illustration, the spring is connected in the usual way to the pencil mechanism, but with this difference—that the indicator is connected to the cylinder at the side, an angle cock being furnished for horizontal engines. The indicator piston is below the inlet, therefore the steam acts upon the top of the piston and elongates the spring instead of compressing it, as in the inside-spring indicator. This makes the pencil movement opposite that of the older type,

and the atmospheric line is at top of indicator card. In its construction, the area of the indicator piston is ¼ of a square inch, whereas it was ½ square inch. As the total pressure is thus reduced, the spring may be made of much smaller material, which insures greater elasticity and freedom of operation. The piston moves in a closed cylinder which is secured at the bottom, leaving a space that virtually forms a steam jacket. This construction allows the ready removal of the inside cylinder and the piston for examination.

The outside-spring indicator is being used more and more in power plants, and also in many leading technical schools, for testing and comparison with the older forms of indicator.

New Desk Telephone

THE CONNECTICUT TELEPHONE AND ELECTRIC COMPANY, of Meriden, Conn., have placed upon the market a new type of desk telephone. All working parts of the stand are entirely enclosed, making it free from handling and absolutely dust-proof. The hook switch is small and durable. This instrument has been highly complimented, both for finish and for mechanical construction. It is equipped with the company's new solid-back transmitter and self-contained receiver, which make the instrument one of the most powerful yet placed upon the market. A bulletin describing the stand, showing the inside and outside construction, will be mailed by the company on request.



HIGH-SPEED MOTOR-DRIVEN PUMP.

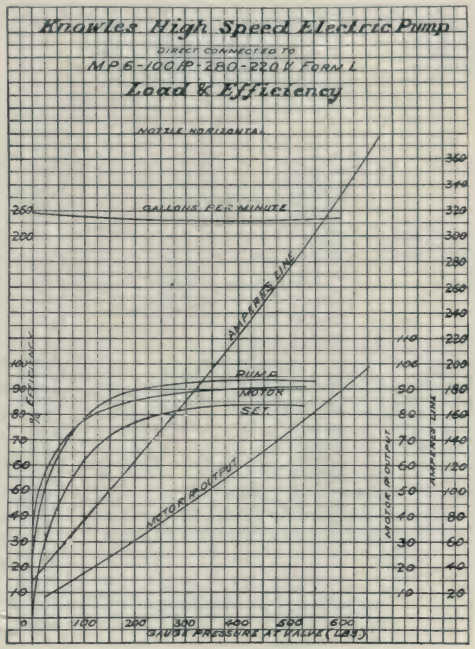
High-Speed Motor-Driven Pump

THE USE of the electric motor for the operation of pumping machinery offers, especially in mines, many obvious advantages over compressed air or steam. Nevertheless, electric-driven pumps have had one drawback, which was the necessity of toothed gearing, belts, or other devices to transfer the power from the rapidly revolving motor shaft to the slow-moving crank shaft of the pump—which added to the weight and size of the pumping unit and required either careful attention or frequent repairs. The

use of toothed gearing on pumps in buildings is, moreover, objectionable on account of noise.

These objectionable features have been eliminated in the pump shown in the accompanying cut, in which the pump plungers are connected to cranks mounted directly upon the shaft of the motor. The capacity of this pump is about 250 gallons per minute against 1,000 feet head, when running at a speed of about 300 revolutions; while it is claimed that its mechanical efficiency is over 93 per cent, approximating closely that of the highest types of large steam pumping engines. The pump is of the duplex type, the cranks at the opposite ends of the motor-shaft being set at right angles to each other. The plungers are of the outside-packed pattern, and the two plungers of each pump are connected by side rods. The plungers are 3½ inches in diameter and have a stroke of 5½ inches. In a carefully conducted test, very satisfactory results have been obtained, as shown by the accompanying table and curve sheet:

This type of pump, which has recently been introduced, has several advantages, such as cheapness of installation and attendance, simplicity of construction, and small space requirements. The pumps are built by the Blake & Knowles Steam Pump Works, New York City, in capacities of from 200 to 4,000 gallons per minute, and for heads varying from 100 to 2,000 feet. One of these pumps, operated by a direct-current motor, will be exhibited in the space of the General Electric Company at the St. Louis Exposition.



Pump Test Data.

PUMP TEST

Blake-Knowles High-Speed Duplex Pump—3½-inch Plungers, 5½-inch Stroke—Direct-Connected to a General Electric 100-H. P. 6-Pole 200-Volt Shunt Motor.

R. P. M.	Motor Input, Watts.	Gallons Del.	Pressure, Lbs.	H. P.	Motor Pump	Efficiencies, Per Cent.	
						Motor Alone	Pump Alone
280	28,800	237	110	32.63	78.0	86.5	90.1
280	40,600	237	215	48.94	82.2	89.0	92.36
280	52,550	235	321	62.25	84.4	90.1	93.66
280	60,200	234	425	74.53	84.3	90.9	92.74
309	58,800	232	496	71.79	83.3	....	.....

The pump and motor are so mounted that the unit is self-contained and compact. Many novel features are embodied in its construction, and careful attention has been given to the design of the internal parts, as well as to the running parts and oiling devices.

Concrete-Steel Railway Tie

THE OBJECT of this invention is to provide a cross-tie of great strength and sufficient rigidity. This is accomplished by covering a framework of

metal with a plastic material (concrete). The metal provides the strength, and the concrete protects the metal from corrosion.

Fig. 1 is a perspective view of the complete cross-tie. It is readily seen that the T-rail forms the reinforcing metallic frame. This is bent at each end, to anchor it more securely in the cement, the radius of curve being small. Fig. 2

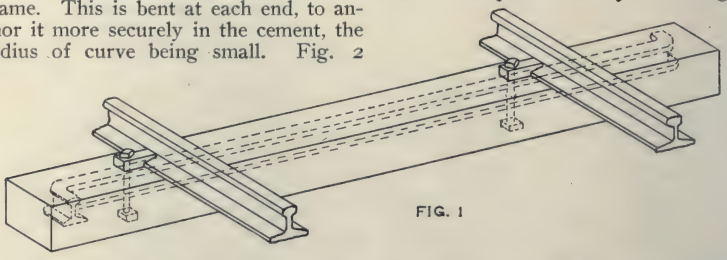


FIG. 1

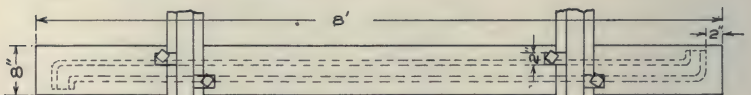


FIG. 2

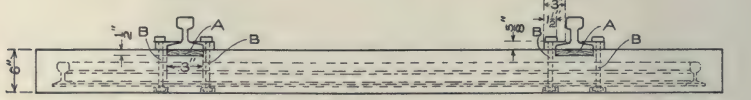


FIG. 3

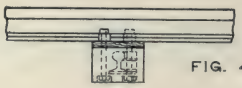


FIG. 4

shows the plan; and Fig. 3, an elevation. The dotted lines indicate the method of securing the rail. The bolts extend through the tie; the square heads are countersunk in the tie to prevent turning. This figure also shows the wooden shims placed under the rails to relieve concussion. Fig. 4 is an end view, showing location of metal frame and rail-locking bolts.

This form of tie was invented by David S. Affleck, and is made by the Affleck Concrete-Steel Railway Tie Company of Chesterton, Indiana. Mr. Affleck is a graduate in the Electrical Engineering Course of the American School of Correspondence.

Substitute for Cotton

WITH REGARD to the statement that a Rochdale engineer and weaver have sold for £20,000 ($973,300) a secret process for the manufacture of rhea fiber from ramie—a wild grass of the nettle species—Mr. J. W. Lodge, of Sowerby Bridge, writes to say that "the manufacture of this vegtable fiber is now well understood, and the initial and original difficulty of degumming has long since been overcome. To-day, I have sleeves and tops ready for spinning, of the most perfect and beautiful character, which we can produce in unlimited quantities at about 4½d. (9 cents) per pound —considerably less than the price of raw cotton. Its purity and intensity of silky whiteness, its softness and tenacity, exceed anything that can be obtained, in my opinion, from the best American or Egyptian cotton." Mr. Lodge states that he has manufactured the grass into cloth, dress goods, ropes for lifting or driving purposes, and other articles. The material, he says, is capable of being made up into the finest plush fabrics on account of the length and tenacity of its staple.—*London Daily Mail*, May 18, 1904.

Noon Hour Talks

Habit—A Good Servant or a Bad Master

"IF an idiot were to tell you the same story every day for a year, you would end by believing him." So said Burke, when discussing the influence of habit; and though the statement sounds radical, it contains a large element of truth. Life is made up of an infinite number of little things, repeated over and over again until their performance becomes so mechanical that they are done unconsciously.

Animals and Men Alike.

When you climb a stair you always take the first step with a certain foot. When the hand is raised to the face it almost invariably touches one certain spot first; and so on, of a thousand other acts. Life is made up of unconsciously formed habits. In the course of time these habits acquire a power over us that enslaves every function of the mind and body with chains that few are capable of breaking. The same phenomena of habit are found in animal life. A certain clergyman, living in the outskirts of the city, drove every morning into town for his mail. The horse, from habit and with no suggestion from his master, went each week-day morning directly to the post-office, but on Sunday morning passed the postoffice and went straight to the church. A friend once told me of a dog owned by a neighbor—who, by the way, was a Quaker. First day and fifth day of each week the dog went to meeting. If the family went, he went with them; if not, he went alone, and always occupied the same place.

Just Once More.

It is so easy to form habits—good and bad. Just one little lie to help you out of this difficulty. Just one little indulgence, and a good night's sleep will fix you up all right. Just one small part of your work slighted—nobody will notice it. Quite true, but the facility and inclination acquired by such acts will lead to their repetition, until you become, even against the protests of your better nature, a slave to them.

The Fault-Finder.

One of the most common and objectionable of habits is that of fault-finding. Certain people never see the wallet on their own backs, though everyone carries two packs—one before, stuffed with the faults of his neighbor; and the other behind, stuffed with his own. If the best man that ever lived had his faults written on his forehead, he wouldn't walk a block before drawing his hat over his eyes. Thomas Carlyle is one of the great names in literature, but for years he was the champion fault-finder of Great Britain. He was "down" on everything and everybody. On one occasion he rode sixty miles to consult an eminent Edinburgh physician about his health, and, on his return, expressed himself in the following terms:

"I find," he said, "that I might as well have ridden sixty miles in the opposite direction, and poured my sorrows into the long hairy ears of the first jackass I came upon, as consulted with this medical man, for all the good he did me."

This habit of fault-finding wasted more of Carlyle's energy, and cast a shadow over more of his pleasures, than the real obstacles which beset his path. Don't attempt to regulate the world, it's a big contract.

A Fit Rebuke.

One of those people who fail to see or find anything without picking a flaw in it, received an effective rebuke while visiting St. Louis last month in company with a friend. In the evening after the first day's sight-seeing, the fault-finding gentleman suggested that they meet next morning at the gate of the Palace of Electricity. To his astonishment his friend replied:

"I will tell you frankly, I would rather not see any more of the Exposition with you. I came to St. Louis to enjoy myself, and that enjoyment needs the accompaniment of sympathy with others. Now, you seem to dislike everything, find fault with everything; you do not see anything which you do not find inferior to what you have seen before. This may be very true, but it makes me uncomfortable. I believe that if I were forced to live with you, I should commit suicide."

Gentle reader, don't be a chronic kicker.

The Boy and the Button.

There was a boy at school who always stood at the top of his class. The boy next to him noticed that when answering a question he always fumbled with his fingers a particular button on the lower part of his vest. Chance offered an opportunity, and the observing lad removed the button with a knife. When the boy was again questioned, he felt for the button, but it was not there. He looked confounded, stammered, and sat down. His companion answered the question and got his place. Guard against forming any of these seemingly insignificant habits; when you least expect it, they will place you at a disadvantage.

How shall I a habit break?
As you did that habit make.
As you gathered, you must lose;
As you yielded, now refuse.

Thread by thread, the strands we twist,
Till they bind us neck and wrist;
Thread by thread, the patient hand
Must entwine ere free we stand.

As we builded stone by stone,
We must toil, unhelped, alone,
Till the wall is overthrown.

In order to receive attention in the columns of THE TECHNICAL WORLD, all inquiries must be addressed to the Consulting Department, and must be accompanied with the *full name and address of the sender.*

Gasoline Engines

Question: I am very much interested in gasoline engines at present, and should like to have you answer the following questions:

1. Can two engines (gasoline), one a 12-H. P. with a 24-inch pulley running 260 R. P. M., and the other a 20-H. P. with 30-inch pulley of 230 R. P. M., both belted to driven pulleys on the same line shaft, using pulleys of proper size to run the shaft 200 R. P. M., be operated so that the engines will work in harmony?

2. How much more gasoline will it require to run a 30-H. P. engine than it will to run a 12-H. P. engine after both engines are in motion?

3. Which would be the more economical—to run two engines (one a 12-H. P. and one an 18-H. P.), or to run one 30-H. P. engine, where the load would vary from 8 H. P. to 30 H. P.?—*D. H. S.*

Answer 1: Yes.

Answer 2: This would depend entirely upon the engines and the efficiency at which they were operated. Approximately it would take a little over twice as much fuel for the larger engine, both running at full load.

Answer 3: There are so many variable factors connected with the economical running of these engines, that it would be impossible to make any positive statements regarding the comparative advantage of one plant over the other. Gasoline engines should always conform to the work to be done. They always show a large increase in the consumption of fuel per actual H. P. with a decrease of load. Consequently if the engines can be made to run at their maximum load continuously, there would be a saving of fuel. If the two engines were used, it is possible that they could each be kept at nearly their maximum load continuously, and this would give the best economy; but, on the other hand, if the load changed many times during the day from its maximum to minimum, it would necessitate considerable attention to keep the engines running at their best economy. Besides the cost of fuel, there is the attendance to be figured on (which, however, should be small), and the loss which would result from a complete shutdown of the plant. If two engines were in use, this would provide against the latter contingency and would be a point in their favor.

Taking everything into consideration then, it would appear that the two engines would be the more economical.

Range Finding

Question: Will you kindly explain to me the principle of the range finder used on board ships of war, and how many different kinds there are, etc? I know not the first thing about them, and any light you may throw on the subject will be greatly appreciated.—*W. C. T.*

Answer: The art of locating the range of an enemy's ship in time of war is a very important one, and is worked out on a scientific basis. There are several methods by which this can be done.

FIRST: The distance can be determined very accurately by trial shots with quick-firing guns. The range of these guns is known exactly; and, since they can be fired very rapidly, the distance is readily ascertained.

SECOND: The distance to the enemy can be determined approximately by noting the time between the flash and report of the enemy's gun. Special instruments have been devised for facilitating these observations. These involve the use of the stop chronometer, thermometer, microphone, etc.

THIRD: The third method is by use of the telemeter, or range finder. This instrument, which is made in many different styles, consists essentially of a surveying instrument capable of measuring an angle. This involves the principles of trigonometry; that is to say, one side is known and two angles of the triangle are readily determined.

There are two types of instrument known under the name of "Fiske." One automatically indicates the distance by a variation in electrical resistance, caused by changes in the instruments as they indicate corresponding angular changes. Theoretically the most accurate results are obtained by two telescopes, one at each end of the ship; but in actual practice, these are pretty sure to be deranged by the concussion incident to a battle. In these observations, the side of the triangle known would be the distance between the two telescopes, and the angles would be found by sighting the enemy through each telescope, two observers being necessary.

Nordenfeldt and Middleboe's range finder calculates the distance in yards directly by measurement of an angle subtended by the distance from the water line of the enemy's ship to the horizon.

Searle and Saegmuller, have invented a type which is very extensively used. It involves the principles of optics as well as trigonometry. In instruments of the above type in which the base line—that is, the distance between the two observing telescopes—is but a few feet, the range can be located within one per cent, at a distance of one-half mile.

Boiler Design

Question: I am designing a boiler for practice and have met with a difficult question. The area of the segment above the tubes to be braced is 621 square inches, and the pressure 100 pounds of steam.

1. Kindly state the number of braces it takes, and also if the foot of the brace will have to be the same area as the body of the brace; also, the pitch of the rivets and the pitch of the brace.

2. Also, can you design a boiler by having the horse-power, length, and steam pressure given, instead of having the steam consumption of the engine given?

3. Also, explain the figuring of reënforcing of a manhole so that the strengthening plate may be equal to that which is cut out.—*P. J. H.*

Answer 1: The number of braces will always depend upon their form. Assuming that the ordinary crow-foot pattern would be used, it would require 9 stays, 1⅛ inch in diameter. There should be at least 3 inches between top of tubes and the lowest row of rivets. The upper stays should be spaced about 15 inches on centers, the others being spaced symmetrically on the segment. The pitch of the rivets should be from 3½ to 5 inches, probably 4 inches would be sufficient.

Answer 2: No, not for best results, since some engines consume from three to four, and more, times as much steam as others for the same power; and hence there would be no method for determining the capacity of the boiler.

Answer 3: The section of the ring should be made equal to about .7 the sectional area of the material cut out. Without making any calculations, however, it is good practice to make the width of the ring not less than 2½ or 3 inches, and the thickness at least one inch, the rivets having a pitch of about 3 inches.

Loose Piston Rings

Question: What makes the rings of an engine click when the load is removed, and continue to do so, when running at normal speed, until the load is applied again?—*B. W. J.*

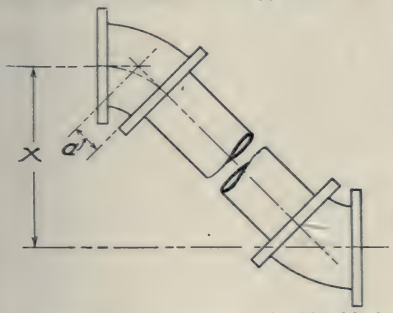
Answer: It is impossible to state conclusively the cause of this "click," unless one is able to investigate this matter closely, while the engine is in operation.

It is sometimes even then difficult to locate the point whence the sound comes. The only solution which occurs to us from this distance, assuming that the noise is really caused by the piston rings, is as follows:

Under no load, the steam will often expand below atmospheric pressure in a non-condensing engine; and, on the opening of the exhaust valve, there will be a sudden rise in pressure, and this sudden change might produce a motion in any loose parts, especially in the piston rings, if they should be worn to any extent. Under full load, the pressure is more constant on one side than under no load.

Computing Length of Pipe

Question: I wish you would give me a rule for computing the length of pipe between two ⅛ bends (45° elbows). In the sketch which I enclose, the measurement would be from center to center of each ⅛ bend.—*C. T.*



Answer: A problem of this kind, simply resolves itself into finding the diagonal of the square, one side being known. In the figure, you will see that this one side, of course, is the offset x. The length from center to center of the elbows, then, is found by multiplying the offset x, by the factor 1.414. For instance, if the distance x was 5 feet, the length of pipe would be 5×1.414 (= 7.07) feet.

Practically, however, if exact measurements are necessary, you must allow for part of the elbows themselves. Assuming the pipe to enter the elbow up to the depth of the flange, we should then have to allow the distance from the flange to the center of the elbow. This is indicated as a in the accompanying figure. This exact distance should be determined by actual measurements. Since there are two elbows, we should subtract twice this distance from the length as calculated, and the answer will be the length of pipe necessary.

Boiler Tubes and Threads for Bolts

Question: What is the most practical way of cutting the tubes from the front and rear ends of the firebox of a boiler?—*E. N. B.*

Answer: Break the pipes just back of the ferrule, with a tool provided for the purpose. The beaded ends can then be knocked out.

Question: What standard is employed when threading bolts to be used in the sheets of steam boilers for brackets, etc?—*E. N. B.*

Answer: The U. S. standard. The rule by Mr. Sellers for proportioning the thread is as follows: Divide the pitch—or, which is the same thing, the side of the thread—into 8 equal parts; take off one part from the top, and fill in one part in the bottom of the thread. Then the flat top and bottom will equal ⅛ of the pitch. The wearing surface will be ¾ of the pitch; and the diameter of the screw at the bottom of the thread will be expressed by the formula:

$$\text{Diameter of bolt} \left\{ \begin{matrix} \\ \\ \end{matrix} \right. \textit{minus} \left\{ \begin{matrix} \\ \\ \end{matrix} \right. \frac{1.733}{\text{No. of threads per in.}}$$

The angle of the thread is 60°.

Testing Generator for Polarity

Question 1: Kindly explain the best way of finding out if there is a difference in polarity in the fields of a generator, and the best remedy.

Question 2: Kindly explain the best way of telling which is the positive wire of a dynamo or motor.—*S. R. J.*

Answer 1: There should be a difference of polarity in the fields of a generator, and it is possible to determine the polarity by means of a pocket compass. In a bipolar machine, one pole should be north and the other south. In the multipolar machine, the alternate poles should have opposite polarity. In case the polarity of both pole-pieces is the same, there is, of course, something wrong. The connections should be changed to bring about the proper conditions of polarity; and if the residual magnetism is de-

stroyed or reversed, a current must be passed through the fields from an outside source.

Answer 2: If a voltmeter is at hand, the positive terminal can be determined by connecting up to the voltmeter; if it gives a direct reading the positive terminal of your machine must be connected to the positive binding-post of the voltmeter, which is always marked. Another way would be to put the terminals in water, when bubbles will be found to arise twice as fast from the negative terminal. In case of a motor you can run it as a dynamo and use the above methods. Another way would be to apply Fleming's rule, supposing you know the polarity of your fields. In case of a generator, use the right hand, placing the thumb and first and second fingers at right angles to one another. Let the thumb point in the direction of motion of the conductor; the first finger in the direction of the lines of force, which will be from the north to the south pole; and the second finger will then point in the direction of the induced electromotive force and current. In the case of a motor, follow the same method, using the left hand.

Theory of Quadratic Equations

Question: What is meant by the "Theory of Quadratic Equations?"—*P. O. S.*

Answer: The branch of Algebra that treats of the properties of a single algebraic equation of the second degree, containing one unknown quantity.

Babbitting of Bearings—Pump-Valve Adjustment

Question 1: Explain fully how to babbitt the main bearing of an engine, the bearing being worn considerably.

Question 2: Explain how to adjust the valve of a double-action Knowles pump.—*F. T. T.*

Answer 1: To re-babbitt a box, use 10 parts of copper, 72 parts of tin, and 18 parts of antimony, for high speeds; and 32 parts of lead, 20 parts of zinc, and 48 parts of antimony, to resist rapid wear. In the latter case the zincs should first be melted and the other parts then added. The boxes should be re-babbitted around a mandrel rather than around the shaft-journal, but frequently this is not convenient. In either case proceed as follows:

Wet a piece of thin writing-paper with oil, and wrap it around the journal of the mandrel (the oil will cause the paper to stick to the journal); let the joint in the paper come on the side of the journal between the boxes; heat the boxes before pouring off; lay the mandrel in place, and let it remain until the journal and boxes are both warm, but not so as to burn or scorch the paper. The mandrel should then be taken out and the oiled paper stuck around it. Pour the metal around the outside of the paper. After the lower box is poured, pack between the two with layers of paper or strips of wood; and put on the upper box, bolting it down. After the upper box is poured, remove it and take off the paper, which will leave the journal free to run without heating.

Answer 2: To set the chest piston, loosen the set screws in the tappets on the valve stem. Then place the vertical arm on the piston arm at mid-stroke, and have the rocker bar in a horizontal position. The chest piston should then be located centrally, the piston being rotated slightly to obtain this position by adjusting the connection between the rocker bar and the valve stem. Then turn the valve piston one way or the other to its extreme position, put on the chest cover, and start the pump slowly. If the stroke is longer one way than the other, simply lengthen or shorten the rocker connection. In case the pump does not act promptly in making its return stroke, the rocker roller is too low, and does not come in contact with the rocker bar soon enough. When the length of motion is properly adjusted, the vertical arm should not quite touch the collar and the clamp on the valve spindle.

Gas-Engine Ignition

Question: Can a telephone generator be changed to furnish current sufficient for gas-engine ignition, and what changes would be necessary?—*A. H.*

Answer: Since direct current is required for gas-engine ignition, it would

be necessary, first of all, to place a commutator upon the generator. A telephone generator thus equipped could then be used, but would not give the best results, because it would not furnish a sufficient amount of energy; and, on account of there being only two segments to the commutator, there would not be sufficient continuity of current. Moreover, the field would not be sufficiently powerful. Generators are now made specially for the purpose of gas-engine ignition, but would have several coils in the armature winding, and a commutator with a corresponding increase in the number of segments. It would also be wound with larger wire and fewer turns.

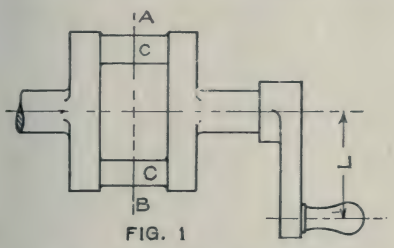


FIG. 1

Stress in Shafts and Cranks

Question 1: Kindly explain how to find the stress in the bars CC, Fig. 1, when the crank is turned, for a circular section as in Fig. 2, and for a rectangular section as in Fig. 3.

Question 2: Explain by formula how much the strength of a shaft is decreased by drilling holes through it for pins, as shown in the accompanying sketches.

Question 3: In answering the question in the June issue for M. A. M. about heating of water, you stated that each square foot of copper pipe will give 200 B. T. U. to the water per hour. How many B. T. U's can I figure on to get from brass pipe?—*L. P. M.*

Answer 1: The two parts of the shaft are driven by the bars C, which are evidently in shear. Letting S equal the shearing resistance of the pin, we have:

$$W \times L = 2 \times S \times y,$$

in which W = force at the arm; L = length of the arm; y = distance to center of section of bar C. The stress

$$S = \frac{W L}{2 y}.$$

Answer 2: The strength of the solid shaft is expressed by the equation

$$Z_p = .196\ D^3 \text{ (D = diameter)};$$

and the strength of any section, by the approximate formula:

$$Z_p = \frac{A^4}{40\ I_p \times y},$$

in which A = Area of section; I_p = Polar moment of inertia of section; and y = Distance of furthest edge from center of section. The difference between these

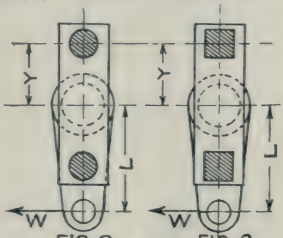


FIG. 2 FIG. 3
SECTION A. B

two expressions will show the decrease in strength. If the holes are very small —say 1-10 diameter of shaft or less—the strength is decreased not more than one-fiftieth.

Answer 3: The heat transmitted by brass and copper is generally considered about the same, about 200 B. T. U. per hour. The exact amount depends upon the condition of the surfaces, the circulation, etc. It has been found that 200 is a safe figure to use in calculations.

Turbines Applied to Locomotives

Question: Is there any possibility of the application of turbines to locomotives? If practicable, would it not result in lengthened life to engine and roadbed, due to decreased vibration?—*G. L. D.*

Answer: The application of turbines to locomotives is certainly a possibility. The steam turbine is yet in its infancy, and no one can say what it may not be applied in the future within its legitimate field. One of the great advantages of its use would certainly be the absence of those vibrations that accompany the action of the reciprocating parts of the locomotive of to-day.

A Cactus Farm

A MILE south of Phœnix, close to the usually dry channel of Salt River, is one of the oddest farms in America. It is planted to nothing but cactuses, of every species found within Arizona. Each kind, as far as possible, is cultivated under the same conditions as prevail upon its native heath, and most of them thrive well under the hot skies of southern Arizona, cared for by experts.

The main owner of the farm is Dr. R. E. Kunz, a college-bred German scientist, who has taken up the study of *cacti* and their cousins as his life work. A physician, he has particularly studied the plants for the possibility of securing products valuable in medicine. The utilitarian side has appealed to him in other ways also, and he knows the plants wherefrom come good fruit, those that bear good water for the thirsty desert traveler, and those useful in the architecture of the aboriginal house builder. Arizona has become the source of cactus supply for most of the botanical gardens of the world; and the demand for plants has increased till a lucrative industry has arisen from what would seem to the uninitiated one of the most unpromising floral fields of the world.

Electricity and Vegetation

AN OCCURRENCE of electro-botanical interest, has recently been observed in the Brazilian town of Petropolis, which lies near the city of Rio de Janeiro. Among the commonest plants of that part of the world is a parasitical plant known as the *Tillandsia.* It has very small seeds, each of which is provided with a growth of long, light hairs. At any time of high wind, these seeds are blown long distances in the air, to take root and grow wherever they finally arrive, as, for instance, on the trunks and branches of trees. Petropolis has recently been lit by electric light, the necessary current being conveyed by wires on wooden poles. Seeds from the *Tillandsia* have attached themselves to these poles and to the wires themselves, and have there grown in far greater luxuriance than when in more usual situations, in many places covering the wires with their long green garlands studded with red and white flowers. This is attributed to the effect of the strong light of the electric lamps. It would seem that the various proposals of forcing vegetation by electricity have gained the attentive ear of Nature herself.

Wireless Telephony

ONE OF THE MOST INTERESTING FEATURES in the Electrical Building at the St. Louis Fair, is the exhibit of the American Telephone & Telegraph Company, of the Radiophone. This ingenious device operates as a form of wireless telephoning, and permits one to talk over a beam of light. It consists of an ordinary telephone receiver in circuit with a battery of about twenty cells and a selenium coil. This coil is the most essential feature of the apparatus, and consists of a coil of fine wire wound in a double spiral. The only connection between these coils is through a selenium paste, which in some manner not fully explained is subject to the varying intensities of a beam of light. The selenium coil is placed in the focus of a large search-light reflector.

Just what takes place in this coil is not stated, but it is thought that either the heat or the light waves change the molecular condition of the selenium and hence cause variations in its conductivity.

The coils are placed in a small glass bulb from which the air has been practically exhausted and which looks exactly

like a small incandescent light. The transmitter is arranged to influence an electric arc and a search light, the rays of which are focused upon the selenium coil by means of the concave mirror before mentioned. There are in series with the search light a variable resistance and an impedance coil, the whole being shunted with a condenser of fifty microfarads' capacity.

tests have been made over distances of two miles, with eminently satisfactory results. The idea has been worked out by Prof. Alexander Graham Bell, and perfected by experiments made from time to time by Mr. Hayes of Boston.

No prognosis is given as to the future practicability; nevertheless the station stands as a most interesting scientific experiment, and serves to indicate some-

EXHIBIT OF THE LUNKENHEIMER COMPANY, ST. LOUIS EXPOSITION.

Shunted around the resistance and the impedance coil, is a transmitter of ordinary type used in telephone practice, except that it is much larger and permits a flow of from six to eight amperes. The entire apparatus takes from fifteen to twenty amperes on 110-volt circuit. The sound waves produced by the speaker vary the intensity of the current flowing through the electric arc, and hence the intensity of the light waves, which, at the receiving station, are transformed—by reason of their effect upon the conductivity of selenium—into sound waves through the ordinary telephone.

The length of the light beam in this exhibit is only 420 feet, and serves merely to illustrate the principle. However, thing of the wonderful forces at work all about us in nature and to point toward the results which may be attained at some time in the future.

Lunkenheimer Exhibit at St. Louis

In Machinery Hall is found the unique exhibit of the Lunkenheimer Company. It is easily identified by a large model of their familiar "Valve in Hand," which occupies a prominent corner of the exhibit, as shown by cut.

Pyramids of globe, angle, cross, lever, and gate valves, of various designs and sizes, both brass and iron, are artistically arranged about the exhibit, and are agreeably offset by a black plush curtain at the side and rear.

The glass cases arranged in front of the exhibit contain a smaller class of the goods manufactured by this company—such as lubricators, oil and grease cups, cocks, etc., of all sizes. Neat designs of racks containing various sizes of whistles, injectors, pop valves, and a variety of other specialties, lend to make up an exhibit worthy of notice. A new design of water-gauge, and of oil-pump for cylinder lubrication, are features in themselves.

Dispersed about the exhibit are pipe fittings of every description, together with whistles, safety and check valves and numerous other appliances.

The large variety of steam goods exhibited by the Lunkenheimer Company and manufactured by them, necessitate more than a casual glance in order thoroughly to appreciate the exhibit in all its details.

WE HAVE HEARD from time to time, in a general way, that this has been a dull year — that business has been quiet; and yet the ten months' figures shown by the Department of Commerce and Labor are in advance of those for the preceding year.

Our Nation's Stock Taking

The year 1900 was really a red letter year in exports; but the figures presented by the Bureau of Statistics, of the ten months' exports in the fiscal year of 1904, exceed by $19,000,000 those of the corresponding months in 1900.

The fact that in export commerce the fiscal year 1904 was $19,000,000 ahead of the figures for any preceding year, while it still had two months to run, seems to justify the optimistic view that THE TECHNICAL WORLD has taken of the business conditions of the year.

AMONG THE NATURAL RESOURCES of the Panama Republic the gold mines are worthy of consideration. Within three days of Panama, in the Province of Veraguas, well-defined veins of rich quartz and alluvial gold mines are found. The richness of some of the mines is historical. Spaniards in the early days worked them to such an extent as their artificial knowledge and primitive implements would admit, but were finally obliged to abandon them. At present the titles of forty-five mines are in course of judicial execution. Not all the forty-five are old mines; many of them are recent discoveries; but the majority are contentions over the old mines.

Panama Mines

A movement is on foot for the development of the mineral resources of this republic. Nathaniel Hill, a business man of Panama, is the leader. There can be no doubt that the mining industry will play an important part in the development of the new republic. Access to the region can be had on the Pacific, through the ports of Aguadulce and Puerto Mutis. Cart roads run from the ports to the mines. The climate in the mining region is delightful, the altitude being sufficient to render impossible the enervating climatic conditions found in the lower coast regions.

THROUGH THE LIBERALITY of Mr. Pope, Manager of the Bell Telephone Company, all members of the Exposition Electrical Club at the Louisiana Purchase Exposition have been given the privilege of free telephone service to any part of the country reached by the long-distance lines. The Exposition Electrical Club consists of representatives at the St. Louis World's Fair, of manufacturing concerns, and others directly interested in electrical lines.

Free Telephone Service

IN THE LAST FEW MONTHS the Marconi Wireless Telegraphy has made rapid advances. Russia has installed a Marconi system at Odessa, and also at several other places along the coast of the Black Sea. France, Austria-Hungary, and Spain have witnessed the gradual establishment of the Marconi wireless system; and Norway, Sweden, Holland, and Finland are making ready for installations. It will not be very long before a network of wireless telegraphy covers the entire continent of Europe. Thirty-seven of the Atlantic liners are equipped with wireless apparatus.

Advances in Wireless Telegraphy

Marconi, in a recent interview, said:

"I have been taken up with studying the problem of long-distance work for ships, so that you can send messages now from a shore station to a moving ship 1,500 miles away: thus the shore stations on both sides of the Atlantic will send daily a long news message, which will be received by every ship having my apparatus. Those on the western side of the Atlantic will receive the messages sent from this side; and when the ships are nearer England than America, they will get their daily news from England instead. Thus, you see, we make it possible, with very little effort, to establish and maintain a daily newspaper on board every ship on the Atlantic carrying our instruments.

"There will be twenty of these daily newspapers started within a year, as most of the Atlantic liners carry our system."

The Marconi Company

Mr. John D. Oppe, the close personal friend of Mr. Marconi, besides being Vice-President and General Manager of the Marconi Company in the United States, has also been made General Manager of the Canadian Company. He was chosen by the American directors as manager, because of his sterling qualities. He is aggressive, alert, strong, and progressive, and under his direction the Canadian Company has made giant strides towards success. Stockholders of the American Company have cause to congratulate themselves on his accession to authority.

Our Merchant Marine

The old question of subsidizing the American merchant marine has again come to the fore, and the Congressional Marine Commission are in session, investigating the conditions.

James J. Hill, the railroad magnate, in his testimony before the Commission, opposed the granting of any subsidy, and made an excellent argument, mainly from his own experience in the transportation business.

"The first thing necessary in this matter," said Mr. Hill, "is, in my opinion, the creation of a desire on the part of the American people to own ships. It is a purely commercial question, and must be governed by commercial principles. If there is a profit in this business, the people will engage in it; but if it is the reverse, intelligent men, as in the case of all other branches of business, will get out of it. I have been in the transportation business all my life, and on land the United States has been able to work out a system that has no equal on earth. Our condition on the high seas, however, seems very dismal to me. That our railroad rates are the lowest in the world, is true; and why we cannot create a like condition on the sea, is not clear to me; and so far as my investigations have gone, I am convinced that no amount of direct bonuses will build it into a life that is worth living."

In reply to a question from Mr. McDermott, of the Commission, Mr. Hill said that if we should admit foreign-built ships free of duty, we should very quickly have a merchant marine, although he would not admit that he favored such a step.

John D. Oppe.
General Manager, Marconi Company.

The Deadly Celluloid

Since the original patent for celluloid expired, a vast number of imitation processes have come into being. To-day the average store is flooded with all kinds of celluloid toilet articles, made from gun-cotton compounds. As a result, accidents are by no means uncommon.

Some months ago a young woman's head was set on fire by the sudden combustion of a comb which she wore in her hair. Her life was saved only by the presence of mind of a relative, who threw a rug over her and extinguished the flames.

Celluloid is manufactured from a modification of gun cotton, and the indiscriminate use of articles containing this ingredient is far from safe, especially when the majority of the users have no knowledge of its composition or the danger it may involve.

GRADUATE AND STUDENT NOTES

World's Fair Notes

THE EXHIBIT of the American School of Correspondence at the St. Louis Exposition has been a very popular resting place with both students and friends of the School. The wide, cool seats on either side, and the inviting walls, showing work of students, and pictures of the various buildings, are conducive to a feeling of great relief from the glare and hurry of the exterior of the buildings. Many students have met friends and acquaintances whom they had not expected to see, and also have made new friendships with many of their brother students from across the seas.

England, Australia, Japan, Mexico, South America, South Africa, Germany, and Sweden, all have paid their respects to the American School of Correspondence, and have found the booth a convenient place in which to leave packages or mail.

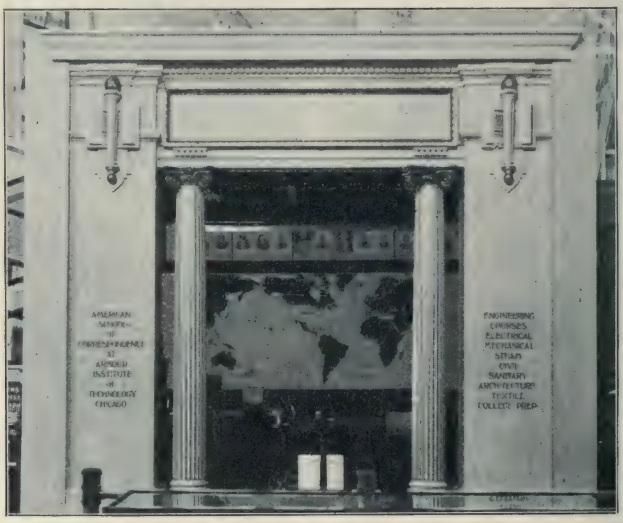


EXHIBIT OF THE AMERICAN SCHOOL AT THE ST. LOUIS EXPOSITION.

It is particularly gratifying to hear two men, absolutely unknown to each other a moment before, chatting together like old friends, and rehearsing some portion of the work which they have found particularly interesting, profitable, or difficult.

We have welcomed many teachers and professors in the past month, from home schools and those abroad. The Presi-

dent of Washington University was amazed at the extent to which our work had gone, and the far-reaching results which had been attained. His whole voice and sentiment are in commendation of the pluck that inspires a man to complete his course of study; and he sympathizes deeply with the system of instruction which makes for a training toward a higher idealism—a greater responsibility and hence a greater degree of usefulness in advancing the various activities of the nation.

The motor generator set, which transforms a direct current of 220 volts' pressure to direct 110-volt current, supplies the light, and is a matter of much comment because of the quietness and smoothness with which it runs, and the slight degree of heat given off. Our telegraph instructor is on duty daily from 9 A. M. to 6 P. M., and the various messages sent can be heard for several hundred feet on either side of the booth. Instruction papers and reference books are on the tables in great profusion, and are in almost constant use by the numerous friends of the School.

THE TECHNICAL WORLD wishes to urge all students and friends to make free use of the facilities which are provided for their comfort. Mail may be directed to the booth, letters written, packages checked, and assistance obtained in seeing the grounds or securing location for room and board. Be sure and register so that your friends may know you have been there.

Bridge Building in West Virginia

THE ACCOMPANYING PHOTOGRAPH of bridge construction shows the work of one of our graduates, Mr. I. A. Andrew, of Medina, Ohio—the raising of a 10-ton 135-foot truss, riveted, to the tower seats about 80 feet above ground.

This is the third viaduct in Northern West Virginia on which Mr. Andrew has been engaged during the last ten months, the average length being about 600 feet. This one is at Clarksburg, the other two being at Morgantown, the seat of the State University.

Here and There

EDOUARD DE SURENTEN, of Chicago, an American School student, Chief Clerk of the Western Department of the Girard Fire Insurance Company, took the examination of *Rough Notes*, an insurance publication for insurance clerks and local agents on the principles and practice of fire insurance. In an account

STEEL BRIDGE UNDER CONSTRUCTION AT CLARKSBURG, WEST VIRGINIA.

of the examination in the Chicago *Record-Herald*, we are pleased to note that Mr. de Surenten attained the highest average for the country. In a special examination in the Fire Insurance Club of Chicago, the leaders were N. L. Sample, of the Traders; J. C. Worton, of the Sun; and L. M. Linnell, of the German American.

A. R. BURTON, employed by the Westinghouse Company, is assisting in the installation of a million-dollar power plant at Green Bay, Wis., for an interurban railway.

LEN A. HUTCHINSON, Engineer of the Electric Light Station of Mulford, N. H., and a graduate of the American School, has had a Grossly Producer gas engine, from Manchester, England, installed, to run a 150-K. W. weight alternator, 1,000 volts primary.

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GRADUATE AND STUDENT NOTES—(Continued)

J. EDWIN STORR, of Lincoln, England, is resident engineer for the construction of a cable network, the initial value of which is $1,250,000.

WE PRESENT a cut of a very fine sky-scraper, the Citizen's Building, Cleveland, Ohio. This structure was designed

CITIZEN'S BUILDING, CLEVELAND, OHIO.

and constructed by an American School student, Mr. J. B. Frauenthal, who is now Consulting Engineer, with offices in the J. D. Rockefeller Building, Cleveland.

CHARLES F. WHEELER, one of our students, has charge of the Mechanical Department of the Kellogg Switchboard & Supply Company's exhibit at the St. Louis Exposition.

JAMES STEVENSON, one of our graduates in Electrical Engineering, has charge of the East Cascade Substation (Power).

J. RUTHERFORD ARMSTRONG, one of our students, is chief of the Substation Supply Power & Light, on the following circuits: 1-10, 2-20, 500 direct-cur-

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THE FOLLOWING INTERESTING ITEM comes from E. W. Miller, a student in Cuba:

Mr. Miller writes that Havana is booming, and the city has $16,000,000 to be "equated" in the next two or three years. There is not a foundry or machine shop on the island of any importance; a well-equipped foundry able to make any sized work, would coin money. Living, and everything else, is very expensive. The natives are well-disposed toward Americans, largely from commercial reasons, as the United States is about the only customer the Cubans have for their sugar, which is their best crop. There is a firm of Chicago engineers in Havana, Messrs. Purdy & Henderson, doing some building and paving. There are two electric light companies, both very poor in regard to efficiency. Mr. Miller makes the startling statement that they have not yet heard of the Curtis & Parsons turbine engine over there.

H. B. COTTER is assistant engineer on the piers and building construction of Hoboken, New Jersey.

The Annual Reception

THE AMERICAN SCHOOL of Correspondence at Armour Institute of Technology is giving sixty thousand wage-earners in the United States and other countries, a technical education by correspondence.

On Friday, June 17, the President and Faculty of Armour Institute of Technology gave a reception to American School students in the Armour Institute Assembly Hall.

For several days previous to the meeting, students had been arriving in the city. Fourteen states and five foreign countries were represented at the reception—England, Denmark, Italy, Spain, and Australia. The majority of the foreign students left for St. Louis the day after the reception, to take in the Exposition.

At eight o'clock, when President Gunsaulus rose to speak, every inch of space in the large Assembly Hall was occupied by students and their friends. In the audience were many of the foremost

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GRADUATE AND STUDENT NOTES—(Continued)

manufacturers of Chicago, their presence bearing witness to their deep interest in the work of the American School. Many, being unable to gain an entrance, met in the laboratories, where arrangements had been made for overflow meetings.

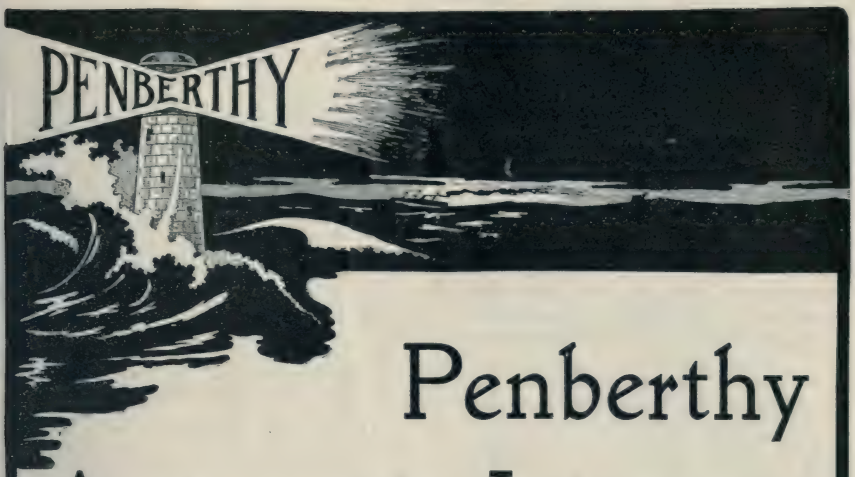
Dr. Gunsaulus introduced Senator Dolliver of Iowa, the speaker of the evening, who, after thanking the Doctor for the invitation to address the American School students, delivered a lecture entitled "A Poor Boy's Country," which held the attention of the audience from the first word to the close. Extracts from Senator Dolliver's lecture will be published in a later number.

After the close of Senator Dolliver's address, guides conducted the students and visitors through the laboratories and buildings of Armour Institute and the American School.

Armour Institute of Technology was the first technical school in the country to enlist its faculty in the work of seeking out that large class of wage-earners, who, by reason of obstacles they could not overcome, have been deprived of the opportunities to secure an education. Instruction by correspondence enables these men to pursue a course of study in a methodical and intelligent manner. It offers a great body of ambitious apprentices, mechanics, engineers, and other artisans an opportunity to come under the influence of the best minds that are now guiding the scientific development of American industries, without losing time or leaving their homes.

The students of The American School are drawn from all ranks of life, all ages, and all parts of the world. There are boys of fifteen; and one student in Massachusetts, doing excellent work in electricity, is seventy-seven years of age. Quite a large number of American School students are playing a part in the Russian-Japanese war. Every time Admiral Togo has attacked Port Arthur, he has carried at least five American School students.

In many of the social settlements throughout Chicago, the American School has established Armour Technical Clubs.



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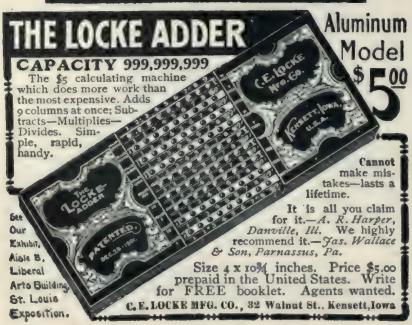

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GRADUATE AND STUDENT NOTES—(Concluded)

Recently Graduated

THE FOLLOWING STUDENTS have been graduated from the American School of Correspondence since the last number of THE TECHNICAL WORLD was issued:

Avila, Miguel, Vera Cruz, Mex.—Course: Mechanical.

Axelson, Oscar, Valley City, N. D.—Course: Special Locomotive.

Ballou, Edward A., Pasadena, Cal.—Course: Stationary.

Ballou, E. H., Binghamton, N. Y.—Course: Mechanical-Electrical.

Buil, Hilario Blanch, Madrid, Spain—Course: Mechanical-Electrical.

Burns, Chas. E., Beverly, Mass.—Course: Mechanical.

Clark, Wm. L., Brooklyn, N. Y.—Course: Marine.

Cline, H. Dale, Bloomington, Ill.—Course: Mechanical-Electrical.

Dero, Louis, Le Havre, France—Course: Marine.

Each, Henry E., South Chicago, Ill.—Course: Mechanical Drawing.

Gore, Chas. W., La Grande, Ore.—Course: Electrical.

Hammond, A. N., Erie, Pa.—Course: Mechanical.

Harrison, W. E., Chicago, Ill.—Course: Stationary.

Hilser, Wm., Newark, N. J.—Course: Electric Lighting.

Hudson, Ross N., Sanborn, N. Y.—Course: Electrical.

Inman, Fred A., Wallace, Idaho—Course: Mechanical (His second course).

Johnson, E. L., Galena, Ohio—Course: Electrical.

Keppel, Thomas, Zeeland, Mich.—Course: Mechanical-Electrical.

Kistler, Otto, Royal Centre, Ind.—Course: Electrical.

Klinger, Jno. S., Fearnot, Pa.—Course: Mechanical Drawing.

Kozlarek, John, Jr., Stissing, N. Y.—Course: Mathematics.

Lehman, E. T., Cambridge, Mass.—Course: Stationary.

Lehmer, Howard, Shanesville, Ohio—Course: Locomotive.

Leite, Lysanias de Cerqueira, Rio de Janeiro, Brazil—Course: Electrical.

Maxwell, John W., Jackson, Miss.—Course: Stationary.

Riter, N. J., Ironton, Ohio—Course: Mechanical-Electrical.

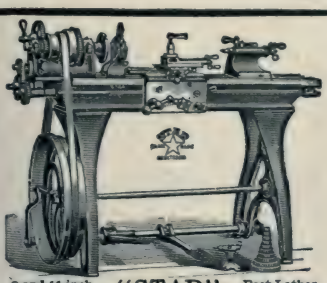
Shearer, H. M., Chapelle, S. D.—Course: Electrical.

Strother, J. E., Ottumwa, Ia.—Course: Electrical.

Tyler, H. Upton, Nevada City, Cal.—Course: Electrical.

Williams, Richard P., Chicago, Ill.—Course: Stationary.

Worley, H., Gretna, La.—Course: Stationary.



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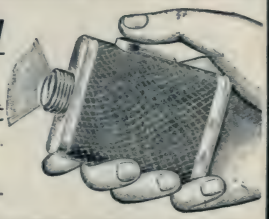

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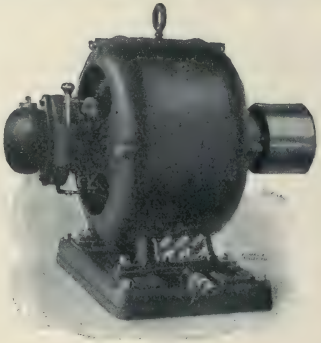

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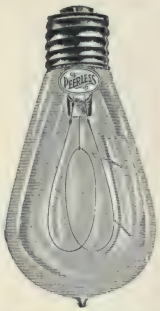

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WANTED—Graduate of the American School of Correspondence in Electrical Engineering, also member of the world's largest private detective association, would like a position with a company wishing to obtain the services of a young man of the above qualifications. Address *The Technical World*, No. 252.

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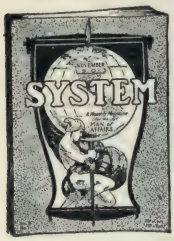

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LITERATURE—(Continued)

are shown by many sketches. The reader is also given the elements of ornamental drawing and a short analysis of the Orders of Architecture, with examples. There are a number of pages devoted to lettering, and a brief treatise on colors and how to use them. The illustrations, while rough and "sketchy," are to the point. The book contains much useful information, and is easily worth its small price to any young man in the building trades who is ambitious to advance.

My Air Ships. By A. Santos-Dumont. Pages 349. The Century Company, New York. Price, $1.50.

THE YOUNG BRAZILIAN, Alberto Santos-Dumont, whose name has been so familiar with the newspaper public through his daring attempts to solve the problem of aërial navigation, has published a most delightful book—"My Air Ships." The subject is not discussed in a technical manner; it is simply the recital of the author's own experience as a builder and navigator of air ships. The work is extremely entertaining. The author tells in a perfectly natural manner the story of daring ascents, and gives a lot of information about aërial navigation that the average man has wanted to know for some time. In several of the chapters M. Dumont refers to his air ships as "Number Seven," a racing machine; "Number Nine," his runabout; and "Number Ten," his omnibus. We question if a more interesting work could be written upon this subject. The book is beautifully illustrated.

Easy Lessons in Architecture. By Thomas Mitchell. Pages 92. Illustrated Industrial Publication Company, New York. Price, 50 cents.

THIS LITTLE BOOK is an excellent example of how the principles and progress of as difficult an art as architecture can be explained in simple language. The author, in his preface, states that the book is compiled with the view of creating a taste in the mind of the young for the noblest of the arts. To the beginner, "Easy Lessons in Architecture" is sure to prove valuable. In a concise way, in the form of questions and answers, it tells about the different styles, their peculiar features, their origin, and the

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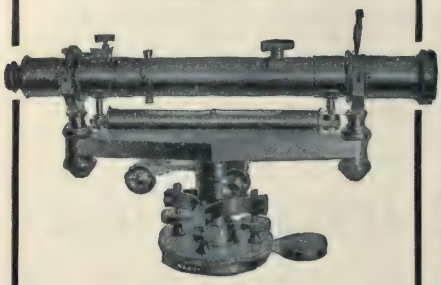

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principles underlying their construction. The work is in its second edition, and has had a large sale.

MAGAZINES

Cassier's Magazine (June)—New York

THIS is the Electrical Power number, and is devoted almost entirely to electrical work. Practically all the articles appearing are written by well-known authorities, and are of the greatest value.

The first article is on Development of Electric Power Transmission, by Lewis Buckley Stillwell. It traces the growth of this important branch of electrical engineering, from the first instance in which the alternating current was used for transmitting electrical energy for supplying apparatus in parallel, at Pittsburg in 1886, to the present day. The writer considers that the most important events in connection with the evolution of electric transmission in America are: (1) The Lawrenceville test of 1886, by which the commercial practicability of the constant-potential transformer—the key to high-potential transmission—was demonstrated; (2) the invention of the polyphase motor, patented by Nikola Tesla in 1888; and (3), the adoption, in 1893, of the polyphase alternating-current constant-potential system as the means of distributing power from Niagara Falls.

Another article, by C. F. Scott, taking up the economic and engineering aspects of long-distance power transmission, is extremely interesting and well worth a careful perusal, as is also that by Paul M. Lincoln on the Limitations of Long-Distance Electric Power Transmission. The following points are mentioned as having to be considered before the problem of installing a transmission scheme is taken up:

Voltage to be adopted; Frequency to be adopted; Regulation to be adopted; Efficiency to be adopted; Prices of copper; Cost of poles or other supporting structures; Cost of labor; Cost of transportation; Price of coal; Cost of power at generating end of line; Value of right of way; Interest rate on investment; Proper charge for maintenance; Proper charge for depreciation; Taxes; Load factor, *i. e.*, Ratio of average to maximum load.

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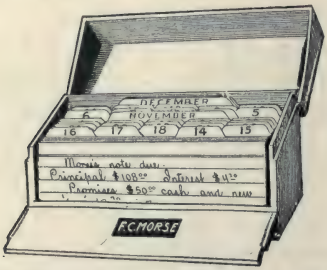

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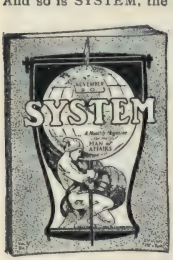

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LITERATURE - (Continued)

line is on Transformers for Long-Distance Power Transmission, by J. S. Peck.

Other articles are:

Electric Power in Manufacturing Plants, by Dugald C. and Wm. B. Jackson.

The Distribution of Electric Power from Transmission Systems, by Dr. Louis Bell.

Electric Power from Shawinigan Falls, Canada, by Wallace C. Johnson.

Electric Power from Shawinigan Falls, Canada, by Ralph D. Mershon.

Electricity and Light, by Charles Proteus Steinmetz.

Electric Welding Development, by Elihu Thomson.

Some British Central Electric Power Stations, by H. F. Parshall, M. Inst. C. E.

Electric Power in European Collieries, by C. S. Vesey Brown, M. Inst. C. E.

American Electrician (July)—New York

ONE OF THE LEADING ARTICLES consists of a description of the Moulineaux Power Station in Paris, which is one of the largest and best-equipped of the plants that have been erected in the French capital within the last few years. This plant supplies current for lighting circuits, and for operating the new electric road which runs from the Invalides Station in Paris to Versailles, as well as other traction lines in the city. The normal output of the station is 7,500 kilowatts. The power is furnished by nine alternators erected by the Westinghouse Electric Company. These alternators furnish three-phase current at 5,000 volts and a frequency of 25 cycles.

The article by George E. Walsh, on The Cost of Water and Electric Power, is very interesting, and some surprising facts are pointed out. For instance, the cost of development of 3,000 horse-power at Vallorbe, according to the capital expended, amounted to only $19.45. In the United States, power from hydraulic plants is delivered cheaper than anywhere else in the world. In Columbus, Georgia, for instance, electrical power is furnished at the secondaries of the consumers' transformers at $15.00 per horse-power per year, the transformers being furnished by the power company. The cost of power at Niagara differs with the amount used, varying from 2 cents per K. W.-hour for small amounts to .64 of a cent for large amounts.

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In discussing the Boston Convention of the National Electric Light Association, reviews are given of the different papers read.

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Other articles are:

Telephone Traffic Department Methods, by Charles H. Coar.

A Convenient Lamp Bank, by George T. Hanchett.

Wiring for Factories, Mills, Etc., by Arthur B. Weeks.

CATALOGUES

Weston Electrical Instrument Company, Waverly Park, Newark, N. J. Portable D. C. Instruments. Pages 53. Paper, 8 1-2 by 10 inches. —— Weston Switchboard Instruments. Pages 69. Paper, 8 by 10 1-2 inches.

CATALOGUE describing, with cuts, portable instruments for direct current. The following points of excellence are indicated in regard to the well-known standard portable voltmeter of the Weston make:

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LITERATURE—(Continued)

of 45 degrees, or to reverse the direction of current in the instrument by an additional movement of 45 degrees.

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Other instruments taken up are Multipliers for the Portable Voltmeter; the Standard Portable Milli-Voltmeter; the Standard Portable Direct-Reading Ammeter; the Standard Portable Milli-Voltmeter with Shunt for Ampere Measurements; the Portable Volt-Ammeter; Laboratory Standard Instruments, etc.; also Galvanometers, Relays, Speed Indicators, etc.

The latter part of the catalogue contains information in regard to instruments for alternating and direct currents.

THE SWITCHBOARD CATALOGUE consists of advance pages from Catalogue No. 15, and takes up the Weston Switchboard Instruments, describing, with excellent cuts, the illuminated-dial station ammeters and voltmeters, and the Weston station shunts. Descriptions are also given of the round pattern of station ammeters and voltmeters, the edgewise instruments for direct current, and the duplex instruments for direct current, the latter being instruments in which both the voltmeter and ammeter are combined, the left-hand scale reading in volts and the right-hand scale in amperes.

The Weston direct-reading ground detector is described, also the arc-light ammeter, the potential indicator, the station differential voltmeter, and zero center instruments.

A supplement is added, which gives dimensioned drawings of the different instruments and prices of same.

Rand Drill Company, New York City. Pages 32. Paper, 6 by 9 inches.

CATALOGUE giving a general description of "Imperial" (Types 10 and 11) Air Compressors, with duplex cylinders, compound air cylinders, and compound steam cylinders. It contains also valuable tables and is illustrated with fine half-tone engravings.

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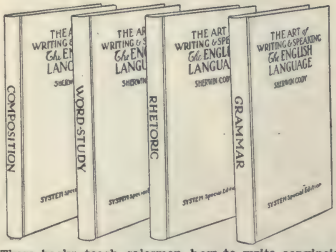

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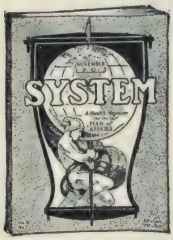

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LITERATURE—(Concluded)

A. L. Ide & Sons, Springfield, Illinois. Ideal Steam Engines. Pages 16. Paper, 6 1-4 by 9 1-4 inches.

THIS CATALOGUE describes Standard engines, the Ideal "Self-Oiling" system, the Ideal throttle valve, and the Ideal governor, with accompanying illustrations.

Evans Friction Cone Company, Boston, Mass. Pages 30. Paper, 8 by 4 3-4 inches.

CATALOGUE describing the Evans Friction Cone, a countershaft for driving machinery requiring different speeds. The device is simple and of great merit. It is operated upon the principle of frictional gearing.

Atlas Engine Works, Indianapolis, Indiana. Pages 36. Paper, 6 by 9 inches.

THIS CATALOGUE contains illustrations and specifications of the Atlas Boilers of the Horizontal Tubular, Six-Inch Flue, Locomotive, Internal-Fired and Vertical types. The details of construction demonstrate the purpose of the manufacturers to build only for the very best results.

The Angle Lamp Company, New York City. Pages 24. Paper, 4 1-2 by 6 1-2 inches.

THIS CATALOGUE deals with the subject of lighting—broadly and specifically. It tells about the Angle Lamp. The Angle Lamp is compared with other methods of illumination—gas, electricity, acetylene, gasoline, and the ordinary kerosene lamp; and its special points of value are fully set forth.

Fitchburg Steam Engine Company, Fitchburg, Mass. Pages 32. Paper, 6 by 10 inches.

CATALOGUE of steam engines, horizontal and vertical. The Fitchburg valve gear and governor are carefully explained and illustrated. The double-posted piston valve is used on the automatic high-speed engines. This company also manufactures boilers, heaters, pumps, etc.

Goddard Machine Company, Holyoke, Mass. Pages 24. Paper, 6 by 8 3-4 inches.

AN ILLUSTRATED CATALOGUE and Price List of grinding machinery, such as tool grinders, automatic knife grinders, etc.

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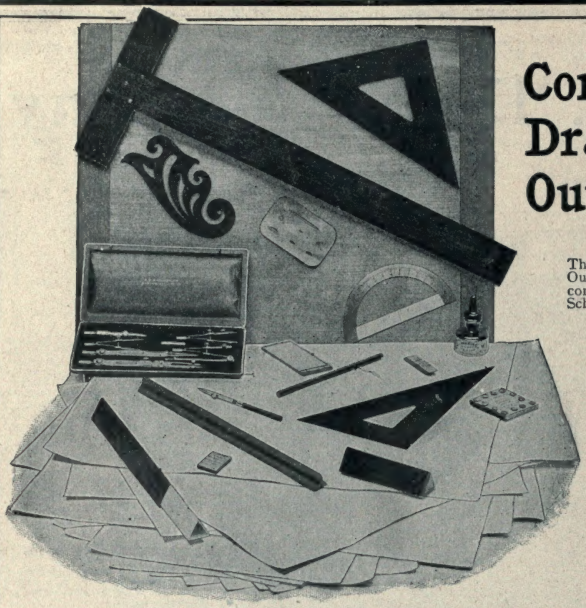

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